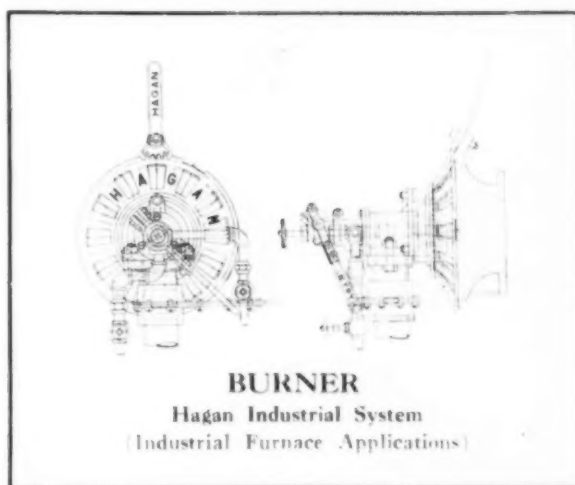
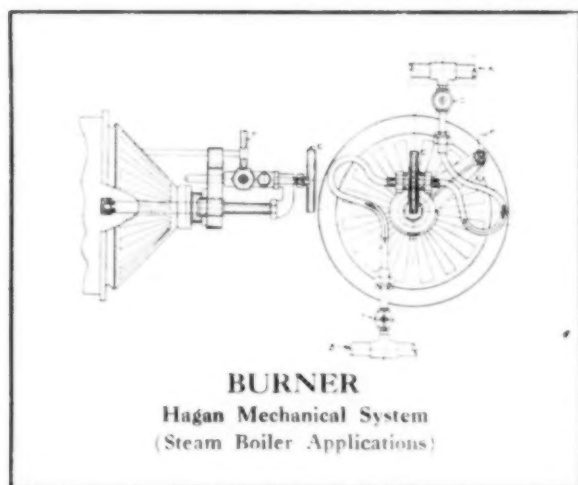


CHEMICAL & METALLURGICAL ENGINEERING

ARE YOU INTERESTED IN
OIL FUEL ?

Then Investigate
Hagan Oil Equipment and Service—At Once



Oil-burning systems from Tanks to Burners
installed, and turned over to clients in operation.

We can offer prompt completion of contracts.

CALL - PHONE - WIRE
GEORGE J. HAGAN COMPANY
Furnace & Combustion Engineers
Pittsburgh - Pennsylvania

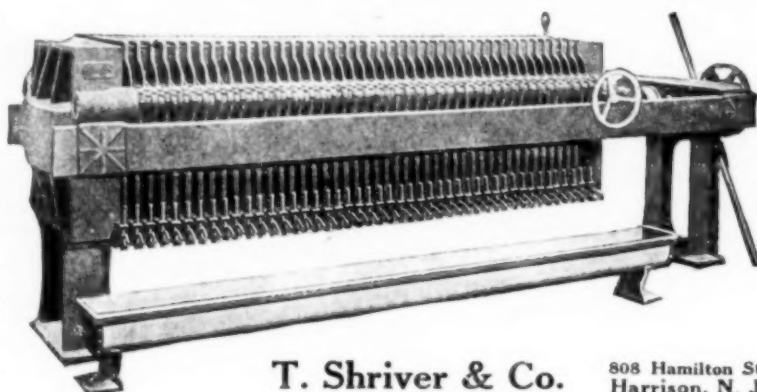
For Big Production and Low Operating Cost

SHRIVER FILTER PRESSES

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

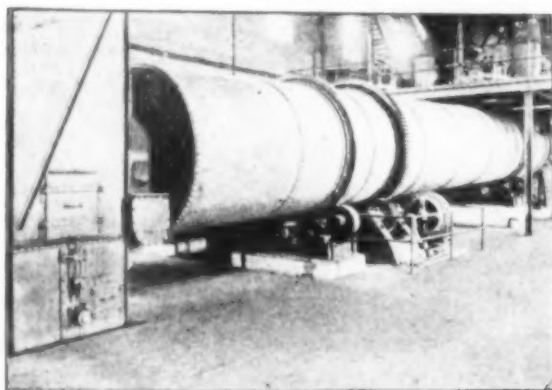
Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



T. Shriver & Co.

808 Hamilton St.
Harrison, N. J.



"Ruggles-Coles" DRYERS

Adhering to the slogan "Continuous Service brings Continuous

Orders" Ruggles-Coles dryers have built for themselves an unequalled reputation for repeat orders.

They are singularly built of the best materials, with low operating costs and maximum efficiency entering pre-eminent in their design and construction. Small wonder that they are used so extensively by the Chemical & Metallurgical Industry!

Write for our illustrated catalogue.

RUGGLES-COLES ENGINEERING CO.
50 Church Street, New York
WORKS: YORK, PA.

CHEMICAL CENTRIFUGALS

"The Finest Extractor made"

That's what the users write us!

"HERCULES—ELECTRIC"

PATENTS PENDING

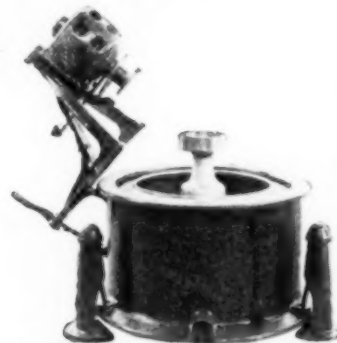
SELF-BALANCING

TOP OR BOTTOM DISCHARGE

DIRECT FLEXIBLE DRIVEN



Type B Motor Driven
Self-Balancing



Only Hercules Extractors
have Motors Mounted on
Tilting Bracket to Facilitate
Removing Basket and
Bearings

Sizes:
30, 36, 42, 48,
54 and 60

Southern Representative
E. S. PLAYER
GREENVILLE, S. C.

Eastern Representative
F. A. TOLHURST
40 So. 7th St.
PHILADELPHIA, PA.

Canadian Representative
Whitehead, Winans, Ltd.
285 Beaver Hall Hill
MONTREAL, CANADA

Write for
Bulletin

EAST JERSEY PIPE CO. -SUCCESSORS TO- **GILLESPIE MOTOR CO.**
PATERSON N.J.

CHEMICAL & METALLURGICAL ENGINEERING

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

Volume 23

New York, October 6, 1920

Number 14

Chemical Exposition A Successful Institution

THE 1920 Exposition of Chemical Industries is past, and the general opinion is that it was the best one yet. It might appear at first that a show made up largely of machinery and products designed for industrial rather than for personal uses might take on a quality of sameness from year to year, and thus grow dull; but the very opposite is the case. As the intelligent public learns to understand and to think in terms of industry; as it achieves knowledge of the immense importance of the nicest control of materials in process, of those subtle distinctions in the quality of output that lead either to success or failure as well as of the direct relation of profits and prices to yield, the means to accomplish these purposes become more generally interesting. And the number of novelties grows. Therefore the industrial chemist with imagination finds at the Exposition signboards pointing to the solution of problems that heretofore have been beyond his reach, while the manufacturer cannot keep up with the game if he stays away. Every succeeding Exposition thus becomes a demonstration of the thesis which is our very *raison d'être*: the application of science to industry.

That the manufacturers are awake to this idea is evidenced by the steadily increasing number of exhibits shown at these Expositions. That the chemical engineers are alive to their opportunities and responsibilities is evidenced by their large attendance and the great interest they evince in new appliances.

The Grand Central Palace is to be transformed into an office building. Therefore the plan for next year involves moving to a great armory in the Bronx which will require about half an hour to reach from 42nd St. The outlook in regard to this change is promising in most ways. It will relieve exhibitors of the burden of a great number of casual, idle, openmouthed sightseers who have no purpose in visiting the show except to use their tickets. Their only value is that they make a crowd; yet there appears to be some kind of an unmeasured psychological value in a crowd. On the other hand we must remember that the best of men are lazy, and that a considerable number of men of affairs who should go but do not know it—because until they visit the Exposition they do not know how chemistry touches their own business—may shake their heads at the extra time required to reach the Bronx next fall.

In every other respect the new site is advantageous. There is room for all exhibits on the main floor. The ventilation is good, whereas the air grew oppressive in the Grand Central Palace. The various meetings, the symposia, and the moving picture shows of industries which have become features of leading importance at these expositions, will be held in a hall properly suited

for the purpose. The old hall was ill-ventilated, overcrowded, and what with the noises of the show and the riveting going on outside it was almost impossible to speak and to be heard. A glance at our records of these meetings will indicate the value of proper housing for them. The memory of a glance at the intelligent audiences which crowded in to hear the papers presented will confirm it.

The management deserves all praise for its earnest effort to make it a great national show; and when we say national we include our neighbors the Canadians. The people of the United States and the Canadians stand up in response to the playing of different national anthems, otherwise they are so inter-related, intermarried and intermixed, and their industries and their affairs are so interwoven, that JOB himself would not have the patience to disentangle them. Aside from this and the welcome offered to Mexican, Central and South American materials, the effort has been to make the show rather national and neighborly than international. When the management found some German-made wares displayed under misleading names, the exhibitors were compelled to withdraw them. In fact, the management is both diligent and constant in its efforts to avoid false pretence and to provide against the presence of all members of the great body of lusty fishermen who are out after suckers. The reward of these efforts is to be found in the general high tone of the exhibits. It would be an interesting study, although difficult and impossible of complete accomplishment, to trace out the industrial progeny, the factories and villages built and the wealth created, which follow as a result of these Expositions.

Harding Reported to Favor Government Operation of Nitrate Plants

THE exigencies of politics sometimes make it necessary for candidates to commit themselves in advance on certain matters placed before them by their constituents. Evidently the farmers have not overlooked an opportunity to secure from Senator HARDING a statement as to his attitude toward the future of the Government's nitrate plants at Muscle Shoals. According to a press dispatch we note that following a conference between Senator HARDING and the National Board of Farm Organizations, a representative of that body said that "Senator HARDING gave his approval to the desire of the farmers to have these plants operated by the Government during times of peace." It will be recalled that legislation bearing on this subject has a place on the calendar at the winter session of Congress. Later on we shall have further comment to make on this subject, but meanwhile it is interesting to note Senator HARDING's attitude.

An Engineering Opinion Of Emergency War Construction

EARLY in 1918 the War Department asked three civilians, two of them engineers and one an accountant, men of prominence and integrity, to review the work then being done in the United States by the Construction Division of the Army, largely consisting in building cantonments and camps. The board was composed of FRANCIS BLOSSOM, of the firm of Sander-son & Porter, engineers, chairman; CHARLES A. MORSE, chief engineer of the Rock Island Railway and assistant director of operation, engineering and maintenance, United States Railway Administration, and W. SANDERS DAVIES, public accountant and president of the American Institute of Accountants. THOMAS H. PIERSON was assistant to the Board and in charge of the Washington office. It rendered a preliminary report just after the Armistice, and the final report, a most voluminous document, has just been printed.

After the several reports of the Congressional committee which investigated war construction and reported in the form of campaign documents, it is refreshing to read the report of the Board of Review, the unbiased judgment of technical men. It confirms what the engineering profession has long known—the war construction was a marvel of speed and effectiveness.

This would have cost much money at best, but especially during the terrific scramble of the summer of 1917. Wage scales were high and good workmen were scarce; much overtime was necessary when supplies were on hand, yet much idleness followed when supplies failed to arrive on schedule; any labor which presented itself or could be found was employed, regardless of its efficiency; and even experienced foremen and superintendents were hard to find. Yet in reviewing war results obtained and difficulties overcome by the industrial home army or the overseas combatant army, the essential test is believed to be the degree of success achieved and not the size of the organization or of its payroll.

The reported total cost of the sixteen National Army cantonments and camps was somewhat under \$200,000,000 and the average daily cost of the war to the United States was about \$30,000,000. If the completion of these cantonments in time to receive the army in September, 1917, and to house it during the extreme winter of 1917-18 shortened the war by only one week their total cost was saved. If it shortened the war by one or two days the total excess cost paid for speed was saved. These figures include no allowance for any saving of soldiers' lives.

In the light of this test, the Board of Review concludes that the Construction Division achieved a degree of success much beyond that expected. Had construction not been pushed at the maximum possible speed cold weather would have caused much delay in this housing work, which, with the difficulty of training troops in severe winter weather, would have greatly delayed the American Expeditionary Forces, and if we can believe our allies' testimony our boys arrived just in the nick of time.

Cost-plus contracts sprang into malodorous prominence in connection with much emergency war work, and doubtless the earlier contracts in more than a few instances provided little return for comparatively large outlay. Yet the Board of Review is of the opinion that the standard cost-plus contract with sliding scale, as

finally developed, and fixed maximum fee contract should be judged primarily in the light of circumstances. Such agreements are designed to obtain speed. As a matter of fact, such a contract permits start of work promptly and without final details; it can be used regardless of size or character of the project; work can be closed or rushed to completion at discretion; prices of materials and labor are under governmental control, and the contract is unaffected by wide fluctuations in these items of cost; and it permits the use of well-tested and existing contracting concerns best qualified to execute the work without the necessity of trusting to untried or specially-assembled organizations. Such advantages on the whole are so great as to be well worth their cost in emergency work, and the Board recommends the continuance of a standardized form of cost-plus contract upon occasion even in peace times.

All in all, the final report amounts to a comprehensive indorsement of the War Department's policy. While strong in its condemnation of the lack of preparedness in 1917, it agrees that the construction work on this side of the ocean was remarkably well done. For future emergencies, the Board of Review strongly urges the immediate organization of a Department of Public Works, a recommendation in which "all the principal national engineering societies concur."

The Flow of Petroleum in Pipes

THE flow of water in pipes has received a great amount of attention, formulas have been developed and the subject has been put on a sound engineering basis. Of recent years hydraulic engineers have extended their activities to include crude petroleum, with the result that pipe lines are carrying the product of the oil fields to refiners hundreds of miles distant. The joint factors of viscosity and temperature have usually been buried in a variable coefficient, which has served as a very convenient letter in formulas that will work forward after it has been determined by working backward. There are many other factors, such as bends, joints, incrustations, lubrication with water and so on that consume pumping energy and affect the flow of the fluid, so that at best the engineer has to study the subject one phase at a time.

In this issue ARTHUR C. PRESTON presents the last installment of his article on "The Flow of Oil in Pipes." It is based on fundamental physical concepts and would be well worth study even if it did not have its important practical applications. It may be true that more simple formulas will be found applicable, especially along the lines of internal and external friction studies as they bear upon energy loss, but apparently we are still some way off from this stage of the development of the science of liquid mechanics at present. No one would guess that a rifled pipe line wetted with water would pass oil with about half the energy consumption taken by an ordinary pipe line. This has been demonstrated, nevertheless. Without doubt the subject of pipe transit should be more frequently discussed in engineering circles than it has been in the past. Every petroleum pipe line operator knows that viscosity is reduced by adding lighter hydrocarbons, and the so-called "vacuum wells" are being used to pull the vapors from the oil beds just for this purpose. Getting maximum oil transit out of the pipe lines is a vital petroleum problem and viscosity is one of its prime factors.

The Individual Engineer And the Federation

ONE pronounced impression received during recent traveling westward into the hotbed of reform and insurgency is the lack of interest in the Federated American Engineering Societies. Technical men seldom or never brought up the subject in their conversation; if mentioned no hostility was shown, neither enthusiasm. It was like an old-line but intelligent voter's attitude toward his Presidential candidate!

CHEMICAL & METALLURGICAL ENGINEERING has long advocated the idea that engineers, by training and experience, are well fitted to render their community a missing yet distinctive and invaluable service. Engineering influence is not yet properly exerted in civil and international affairs, despite enhanced reputation gained during the great war. Everywhere you look you see the work of the engineer, yet in words of the advertising promoter, the engineer is not yet "sold" to the public. All of us know it, all of us hope for a change in the situation. We hope that the Federation will be a powerful influence in the transformation. But unfortunately there seems to be small chance even yet for individual effort, although it is clear that each engineer must feel a personal interest and pride in the movement before it will succeed.

Agitation along these lines has been going on for years. One result was the formation of Engineering Council, to which great hopes were pinned by its sponsors; yet in the light of history even the Joint Conference Committee says: "It . . . is not properly constituted to carry on efficiently the work which it has undertaken; its organization is from the top downward, rather than the bottom upward." Here is tacit admission of our thesis that individual interest is essential. Engineering Council is concededly an appointive board, not a representative assembly with a constituency, and could therefore not pretend to express the views of engineers, by and large.

Yet how has this same error been avoided in the new Federation?

Engineering Council was organized in 1917 as a department of the United Engineering Society, and first acted as a medium of co-operation between the four national engineering societies: Civil, Mining, Mechanical and Electrical. Since then the American Society for Testing Materials and the American Railway Engineering Association have been admitted as members. General officials of each member society appoint their representatives, who collectively form Engineering Council. At present it has over twenty-four committees at work, the personnel of which is drawn from engineers in various parts of the country, and not limited to the membership of Council. Its funds come from fixed contributions from the member-societies, and amount to about fifty cents per individual on the roll of the member-societies—a maximum of \$22,000 in one year.

The Federated American Engineering Societies is likewise a co-operative association of engineering societies, but already its membership is broader than that of Engineering Council, and eventually should include all national, state, regional and local societies of engineers and allied technical men. These societies elect or appoint delegates in any manner they choose, in number based upon total membership, and these delegates meet annually to elect an executive board of thirty members, which largely through the person of an ap-

pointive officer is the body of men which will be expected to produce the desired results. Funds will be contributed by each member society at the rate of \$1 or \$1.50 per individual on its roster, depending upon circumstances.

This new machinery does not appear to be vitally different from the old. Then the engineer elected his national officers, and they in turn appointed the Councilors. Now the engineer may elect his delegates to the Council, which elects the executive board. The doings of this board can become of interest to the man at the bottom only when he feels himself directly represented by men who understand his personal problems, or when they touch and influence conditions close at home. In passing it may be remarked that a lively feeling of delegated authority will not come from making a cross opposite a name selected by a committee.

The Federated American Engineering Societies is now a going concern. Its first meeting will be held this fall. Between now and that time many more societies will join. Like Governor Cox, "We favor going in!" The Federation is not perfect, yet it deserves support and constructive help toward improvement. Its worthy object is to use the best engineering talent to the advantage of our people. Fortunately, the way to this success is exactly the same as the way the Federation may take for its self-preservation, and in this manner:

Like other humans, the engineer is interested in that which most affects him—personally. Strong, active societies and clubs with local boundaries are unquestionably the best if not the only way to arouse his interest in current engineering problems and in the possibility of exerting his influence on public works. At the same time, such a closely knit organization is the best possible tool to use in arousing a public appreciation of the engineer's qualities—local if you will, but national questions are decided by their reflex upon local conditions; witness the tariff. Such a society which can get up and collectively and individually make at least a loud noise when the voice of the engineer should be heard will fairly soon impress the community with the fact that engineering opinion should be given deference—nay, should be sought upon occasion. A state organization formed of such active locals would unquestionably have little difficulty in exercising proper influence upon regional matters, and a national organization comprised of enthusiastic men from these active minor associations could not help but move in the right direction, have the intelligent and active support of the men at home and be a power for good.

While numbers of admirers are casting about in their minds for some big thing for the Federated American Engineering Societies to do, we should like to suggest that the new organization use its funds largely to foster that individual interest which is so necessary and yet so rare. If it will emphasize Article VII of the constitution, and pay great attention to the organization and intelligent upbuilding of local societies, which in turn will agitate the local questions, break into the local papers' editorial and advertising columns and get the engineers working together in the small communities, the preliminary work would be well done. Then when the big question comes along engineers would be working together by habit, and the public would be prepared by past profitable experience to listen to the voice of the united engineering profession.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

London, September 9, 1920.

THE impending coal strike and other labor troubles have been potent factors in the present temporary depression in the chemical industry, and though prices have been fairly well maintained, there is little business passing both for home and export account. Should coal supplies be cut off, most of the chemical factories will have to close down within a week, as stocks are very low; on the other hand, a short strike would give time for much-needed repair work and reorganization in the plants.

There has been considerable demand for bleaching powder manufactured in the United States, and this position is likely to continue, as manufacturers here are fully sold ahead.

The only other feature is a sudden fall in the price of quicksilver, owing to realization of certain stocks, but the price is expected to rise again considerably in the near future.

GOVERNMENT PUBLISHES CHEMICAL ENGINEERING STUDIES

The Department of Explosives Supply of the Ministry of Munitions has issued for sale in book form its preliminary studies for the installation of the cordite factory at Gretna, which was designed to manufacture 39,000 tons per annum. The same volume includes the data for a phosgene factory, the whole of the work being compiled under the direction of William MacNab, an expert of many years' standing in the explosives industry.

The volume contains many detailed drawings of plant and also flow sheets, which should be of the greatest interest to all chemical and industrial engineers, and every step in design and arrangement is clearly explained together with the reasons underlying all decisions as to details. These studies, which are to be followed by further similar publications, should also be of assistance in teaching institutions by showing good methods of applying scientific data to industrial questions. It is also considered that publication will promote closer co-operation among chemical manufacturers and between the chemical manufacturers and the universities.

NEW PROCESS FOR COLD VULCANIZATION OF RUBBER

Considerable interest is being displayed in the new Peachey process (British Patent 129,826), for the exploitation of which a company with a capital of \$1,000,000 has been formed. (See CHEM. & MET. ENG., Sept. 1, 1920, p. 364.)

Briefly, it has been found that vulcanization of rubber both in the plastic and dissolved condition is effected under the action of nascent sulphur obtained by the interaction of sulphur dioxide and sulphuretted hydrogen. The reaction is complete in the cold process within an hour, the vulcanized rubber containing no free sulphur and being therefore free from after-vulcanizing or aging.

The outstanding features are: Saving in time and fuel costs for steam raising; the possibility of using a wider range of coloring materials and fillers, including organic materials such as wood meal, leather buffings, etc.; use of low-grade rubbers, preparation of

rapid cold-curing solutions for tire repairs, jointing and built-up goods.

It is stated that all kinds of coal-tar dyestuffs and lakes can be used, and the production of artificial leather and linoleum substitutes is foreshadowed, it being possible to make boots without stitching and riveting by a simple process of building up. Floor-cloths of this type require no canvas backing and are manufactured in a few hours, as against about a month in the case of oxidized oil products. In addition, all cuttings and waste can be re-used. It seems almost incredible that nearly eighty years should have elapsed without appreciable modifications in the process of vulcanization as originally devised, and the present process will naturally have to undergo the most searching tests and trials before it can be largely adopted. Rubber manufacturers are now devoting increasing sums of money to research, and cold vulcanization has no doubt been the subject of some of the investigations which have been carried out in the past. It remains to be seen whether the Peachey patents have been anticipated and whether results of previous investigations have been found wanting on account of fundamental differences or merely through details of technique or manipulation which have so often proved the deciding factor in industrial processes of this kind.

VISCOSE VS. CELLULOSE ACETATE SILK

The relative advantages and disadvantages of viscose and cellulose acetate silk have been the subject of much unofficial controversy among users, and the advocates of viscose silk have spread reports assiduously to the effect that thread produced from cellulose acetate is not so strong and that it can be dyed only by means of basic dyes. Further, they claim that acetate silk cannot be treated with direct cotton colors and is therefore unsuitable for "union" fabrics, while it is partly decomposed when dyeing is attempted with vat colors of the indanthrene type. Meanwhile, the British Cellulose Co., which is embarking on the manufacture of acetate silk on a considerable scale, has officially contradicted these statements and in addition has drawn attention to the resilient and keeping properties of its silk both in the dry and the moist condition, thus enabling the silk to be spun and manipulated in much finer counts than was commercially possible with viscose silk.

Actually only very small quantities of acetate silk have so far appeared, but it is expected that this controversy will be finally settled when larger quantities appear on the market.

PERSONAL NOTES

Sir John Brunner has been elected chairman of the Council of the Association of British Chemical Manufacturers for the ensuing year and Sir Edward Thorpe has been elected president of the British Association.

The subsidiary appointments under Dr. A. W. Crossley at the British Cotton Industry Research Association have now been made as follows: Organic chemistry, R. G. Fargher; general and inorganic chemistry, Dr. D. Clibbens; colloid chemistry and physics, F. D. Farrow and Dr. A. M. Williams. The program of this association is to be described by Dr. Crossley on Jan. 7, before the Manchester Section of the Society of Chemical Industry.

Sidelights on the Chemical Exposition

Notes of a Casual Observer on the New Developments Featured by the Exhibitors at the Sixth National Exposition of Chemical Industries, New York, September 20 to 25

IN THE notes which follow an effort has been made to touch upon such novelties in products and in methods of exhibiting as the observer chanced to see. The Exposition was big, the walks were long and a large number of exhibits were passed by sometimes because the observer was tired, sometimes because of the crowd and sometimes because time was pressing. It is merely Exposition gossip with no attempt to co-ordinate the notes according to importance, novelty or interest. It is presented with a large "E. & O. E." mark—i.e., errors and omissions excepted. Nevertheless we believe a considerable array of novelties in industry in the way of products, apparatus and ideas will be found by the interested reader.

The artistic possibilities of certain electrochemical phenomena were illustrated by the metallic trees on exhibition at the booth of the American Electrochemical Society. A curious feature in regard to a lead tree formed upon a strip of zinc immersed in a solution of acetate of lead was that at the bottom the wooly, fluffy tree changed gradually between Monday and Wednesday into pure lead crystals. It would seem that there is a hint of natural formations in this process.

While the ability of zinc to withstand atmospheric corrosion has not been as fully appreciated or utilized in this country as in Europe, the New Jersey Zinc Co. exhibit indicated rapid progress in this direction. Among the interesting applications may be mentioned zinc roofing, leaders and gutters, zinc nails for flashings and shingles, zinc nails for recording the year in which railway ties are laid down, door handles and building furniture of pure zinc, and household dishes of silver-plated zinc as well as of the pure metal.

Selenium oxychloride—that interesting solvent described by Prof. Victor Lenher at the St. Louis meeting of the American Chemical Society—was displayed by the Hooker Electrochemical Co. in connection with its line of chlorine derivatives.

The Dorr Co. displayed models of Dorr thickener, agitator and classifier, and small units of the thickener, agitator and diaphragm pump were shown in operation. Another model in operation was that of two municipal sewage plants, both of which begin with a screen, one leading from this to a sewage clarifier, and the other from the screen to a model of the Dorr-Peck process of activation, whereby a saving of 75 per cent of the air is claimed. Of the new Dorr and Petrie process for producing cane sugar without the aid of filter presses and certain other apparatus, only drawings of some of the apparatus were shown.

Few of us are able to sense the artistic in the ordinary chemical plant, but A. H. Kneighton Hammond of England found such inspiration in the plants of British Dyes, Ltd., that Mr. Dow induced him to make a similar set of paintings at the Dorr Chemical Co. works at

Midland, Mich. The pictures are of a kind admired by artists and connoisseurs more than by the general public, but they are remarkable studies in color effects, using various parts of the Dow factory for their subjects.

Public interest in an exposition usually centers upon those exhibits where souvenirs may be obtained. With this fact in mind, the General Bakelite Co. installed a hydraulic molding press which turned out small bakelite cups at intervals of about two minutes. The cup was designed with fine corrugations on the outside and sharply defined lettering on the bottom so as to illustrate the molding characteristics of bakelite. The company showed also an interesting number of objects of art, of which a jade effect was at once new and attractive.

The Research Corporation had a model of a Cottrell electrical precipitation plant in operation, and among the many products recovered were nitric acid from gases and from the fumes of nitrating pots, orthophosphoric acid volatilized and collected in a Cottrell treater, sulphuric acid precipitated from gases in a sulphuric acid plant, a precipitate from blast-furnace gases, containing 28 per cent of potash, bleaching powder made by powdering lime in chlorine gas, and many others.

The General Electric Co. displayed a Coolidge portable X-ray outfit, consisting of a four-piece unit which a physician may easily carry with him in his carriage and set up without outside aid.

Among the products of the company's research laboratory were shown a self-lubricating bearing metal called genelite, special carbon brushes and contacts, a military X-ray outfit for war work, tungsten from the mineral to the ductile wire, boron carbide and its effect on copper castings, a single-piece, flexible cable terminal, a Langmuir vacuum pump split in half to show its operating principle, water-soluble japan, many types of lamps, etc.

New features were the keynote of the large and excellent exhibit of the Buffalo Foundry & Machine Co. The copper construction of its inclined type rapid circulation evaporator makes available to the food products manufacturers this very desirable liquid evaporator. An electrically heated vacuum drum drier demonstrated that temperatures as high as 900 deg. F. could be had. The Hough vacuum nitric retort, condensers and nitrators were shown. A few pieces of sugar plant machinery such as bone char filters were also on display.

Although this was not the first time that the General Chemical Co. and its associates had exhibited jointly, there was evidence of a more pronounced interest in the group as a whole due to the recent announcement of the consolidation of the five companies. The combine, which includes the Solvay Process Co., the Semet-Solvay Co., the General Chemical Co., The Barrett Co. and the

National Aniline Co., is to be called the Allied Chemical & Dye Corporation. As was the case last year, the combined show was at once a model of good taste and of the exhibitor's art.

The exhibits appeared in the order above named, and the Solvay Process Co. showed a flow chart in pictures, a split drum of high grade caustic soda and the usual exhibit of its various products.

The Semet-Solvay Co. had a similar flow chart featuring the production of coke for metallurgical purposes and a model of the refractory construction of its by-product coke ovens. It also showed a model of a modern blast furnace.

The General Chemical Co. showed the Baker & Adamson reagent chemicals, a model of a sulphuric tank car specially designed by this company, having a capacity of seventy tons sulphuric acid, a Herreshoff furnace, a great variety of its own products and a beautiful display of crystal ammonium alum.

The Barrett Co. in addition to its exhibit and the many products of coal tar, which included crudes and some intermediates, showed as new products maleic and fumaric acids, which it is now offering to the trade. They are synthesized from benzene. The company showed also a number of its esters. A curious note in regard to the methyl ester of fumaric acid is that it is solid, whereas the higher esters are liquid. Malic acid, derived from maleic, was also shown, with its qualities as a food acid emphasized. It is claimed to be absolutely non-toxic and it is expected it will take the place of citric acid in foods.

Another exhibit of The Barrett Co. was cumar, a synthetic coal-tar resin which is being offered as material for varnish in place of fossil gums. Similarly a new product, "Barretan," was exhibited, which is a synthetic tanning material used in conjunction with vegetable extracts to reduce cost and increase the speed of operation in tanning.

The National Aniline & Chemical Co. showed a large number of finished articles dyed with National colors, including a happy party of manikins dressed in the latest styles with everything they wore dyed with National colors. A large number of dyes and intermediates were also shown, together with dyed fabrics.

The disposal of large quantities of sulphur dioxide is a problem which confronts many large smelters. Conversion into sulphuric acid offers a solution only when a ready market can be found for the acid. The Anaconda Copper Co., pursuing a somewhat different line of attack, is manufacturing a treble superphosphate containing 48 per cent P_2O_5 from Montana phosphate rock. The ferromanganese which this company has been making since the war contains 76 to 80 per cent manganese. Another new product shown was white lead (made by the Sperry electrolytic process) for which exceptional covering power is claimed.

Instead of having samples of their various dyes E. I. du Pont de Nemours & Co. showed models of the molecules of crudes, intermediates, dyes and explosives made of wooden balls of about 1-in. diameter representing the atoms connected by wires which represent the bonds. These balls were painted different colors.

The exhibit prepared by Dr. Robert E. Rose of the du Pont staff was a persuasive demonstration of the inter-relations between the dye industry and that of high explosives for conditions of war. In addition to

the above there was a great showing of the multitude of du Pont products.

The Newport Chemical Works, Inc., made finished dyes the principal subject of its exhibit, and had living models with brilliant gowns to emphasize the taking qualities of the colors. Only the dyes are guaranteed to be fast. Among the new things shown was a series called anthrene, which are in effect the indanthrene types familiar before the war.

Steps in the manufacture of the basic dyes malachite green, fuchsine and methyl violet were shown by the Dicks-David Co. This company is carrying on elaborate research with one of the rubber companies involving the use of ortho-toluidine as an accelerator in rubber vulcanization. Results to date promise much in the way of a new market for the ortho-nitrotoluene of the intermediate manufacturers.

A new building material was shown by the Porete Manufacturing Co. of Newark, N. J. It is composed of portland cement and sand, made porous before setting and reinforced with wire cloth. It is as light as wood, is a good heat and sound insulator and it may be nailed. It is offered in slabs for sheathing and roofing purposes.

The American Cyanamid Co. showed sodium cyanide, liquid HCN (95 to 98 per cent) for fumigation, urea used as an anti-acid or stabilizer for plastics, artificial leather, dopes, as an accelerator in vulcanizing rubber and as a source of amide nitrogen. Thiourea was offered for photography and for use in organic synthesis. Dicyanamide was displayed as a cheap organic base with 66 per cent nitrogen. Mono-ammonium phosphate was shown for fireproofing, impregnation of matches and as yeast food, while "ammo-phos" fertilizer was specially featured. The list included aqua ammonia, cyanamide, phosphate rock, anhydrous ammonia, nitric oxide, nitric acid and ammonium nitrate.

A novelty in connection with a motor-driven paper-testing machine shown by Henry L. Scott & Co. was an automatic recording device which gives both strength and elasticity.

The General Briquetting Co. of New York had pictures of briquetting plants using culm, at Toronto and at Landsford, Pa., and announced a plant under construction for briquetting carbonized lignite in Canada.

A working model of a Whitaker-Pritchard still was in operation at the booth of the Fuel Products Corporation. This is a device for distilling organic materials such as wood, shale, lignite, coal, etc., in which the material to be treated is placed in a closed retort, and the uncondensed vapors are carried from the condenser by means of a fan through a super-heater, and returned to the retort. Excess pressure drives the gas into a gasometer. The claims are that by the rate of flow the temperature is brought into constant control, the time of distilling is reduced, and the quantity of the distillates is increased.

The Chemical Warfare Service presented the problem of the relation of chemistry to warfare and peace in a very interesting and most instructive manner. By means of charts and labeled specimens, containing in some cases for the first time actual samples of the war gases, the general public was shown the importance of the dye industry as a potential war defense measure. With the same personnel and equipment it was demon-

strated how the same raw material could easily be diverted from the manufacture of dyes to the preparation of one of the most powerful weapons of destruction in modern warfare. Actual production of benzo scarlet dyes from phosgene was demonstrated at one end of the exhibit, while scattered here and there gas shells, bombs, smoke shells, and gas masks brought back vividly the never-to-be-forgotten scenes of the World War.

The vast importance of the protective measure of the dye industry is well illustrated by the fact that Germany was able to produce phosgene at the beginning of the war, whereas it took the United States twenty-one months to develop a method for its manufacture on a large scale.

Mono Corporation of America besides displaying continuous recorders for measuring CO_2 , SO_2 , CO , CH_4 , Cl_2 , O_2 , H_2 , etc., had on exhibit a combination instrument for simultaneously recording the amount of CO_2 and combustible gases ($\text{CO} + \text{CH}_4 + \text{H}_2$) in flues. The curves drawn on the moving chart indicated exactly the efficiency of combustion in any power plant where the Duplex Mono is installed.

By means of the Ceco priming system, a centrifugal pump is enabled to pick up a liquid from below its own level. The use of this device, which is made by the Chemical Equipment Co., is indicated in unloading acid tank cars by pumping over the top and emptying tanks of acid from over the top, whereby the use of bottom outlets is avoided. This company's acid pump of hard lead or other acid resistant material has an open pipe impeller without end thrust, and it appears that it cannot become gas-bound.

A 69 deg. Bé. solution of sodium silicate at the Philadelphia Quartz Co. booth showed a bubble at the bottom of the cylinder on Monday. By Saturday this bubble had worked its way pretty well up toward the top. It suggests a viscosity bubble race in which the last bubble up takes the prize.

Quartz glasses made from a new source of supply which provides unusual clarity were shown by Charles Engelhard and the Hanovia Chemical & Manufacturing Co. They featured among other things photographic lenses made of quartz glass which, owing to its transparency to ultra-violet light, provides for remarkable rapidity.

The electrochemical industries of the Shawinigan Falls region were represented by the Shawinigan Products Corporation, with samples of calcium carbide, synthetic acetic acid, acetaldehyde, paraldehyde, and a white crystalline product called aldemine, which is used as an accelerator in vulcanization.

Butyl alcohol, made by the Weizmann fermentation process, acetone and denatured alcohol, were shown by the Commercial Solvents Corp.

Recent developments in byproduct coke oven design were brought out by the Koppers Co.'s detachable wooden model with the new triangular flues, offering a stronger wall and better control over the distribution of heat.

A self-fixing bottle cap—capes-viscose—was shown at the booth of the Antoine Chiris Co. The bottles of essential oils and synthetic aromatic chemicals were made more attractive by the use of these caps. They are applied in a moist condition and in drying shrink tightly over the cork and top of the bottle, effectually sealing it.

Ammonia obtained by a modified Haber process excited interest in the exhibit of the Nitrogen Corp., which also included unusually large crystals of yellow prussiate of soda and sodium cyanide made by the Bucher process. This company exhibited jointly with Arnold, Hoffman & Co., which showed textile sizes and colors.

The United States Industrial Alcohol Co. featured anhydrous ethyl acetate over 99.7 per cent pure, free from aldehydes and high-boiling esters, which produce disagreeable odors. It is a solvent for both nitrocellulose and cellulose acetate. Another novelty was ethyl-acetoacetate, now produced commercially for the first time in the United States, and used in the dye industry for making pharmaceuticals and perfumes. Anhydrous methyl-acetate 99½ per cent pure, was also shown, as was isobutyl alcohol, refined, and normal propyl alcohol, both of which boil within a range of 2 deg.

A new combination time and temperature controller for the automatic control of gradual and step rises in temperature, an improved Saybolt oil tester and the Pennsky-Martin closed fire and flash tester were featured by C. J. Tagliabue.

The Chemical Company of America, Inc., of Springfield, N. J., announced that it is now selling to the trade direct instead of through brokers and showed about twenty-five dyes with samples of goods on which they have been used.

Dr. Auguste Rossi's titanium white is being developed by the Titanium Pigment Co. under the name "Titanox." It consists of 25 per cent TiO_2 and 75 per cent barium sulphate and has remarkable covering power in addition to being chemically inert.

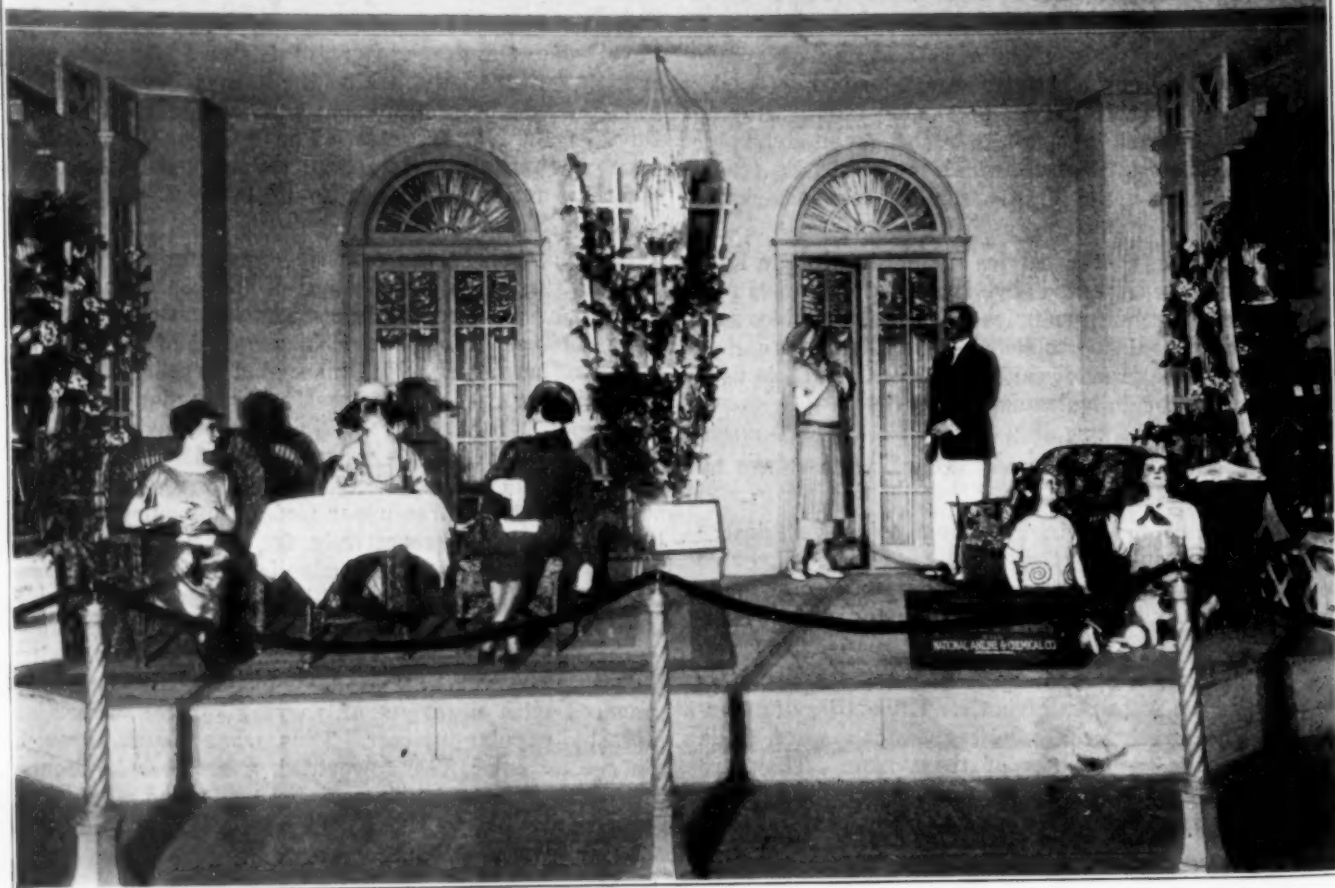
Natural gas served as the raw material in the manufacture of the methyl chloride displayed by Roessler & Hasslacher Chemical Co. for refrigerating purposes for light anesthesia, etc.

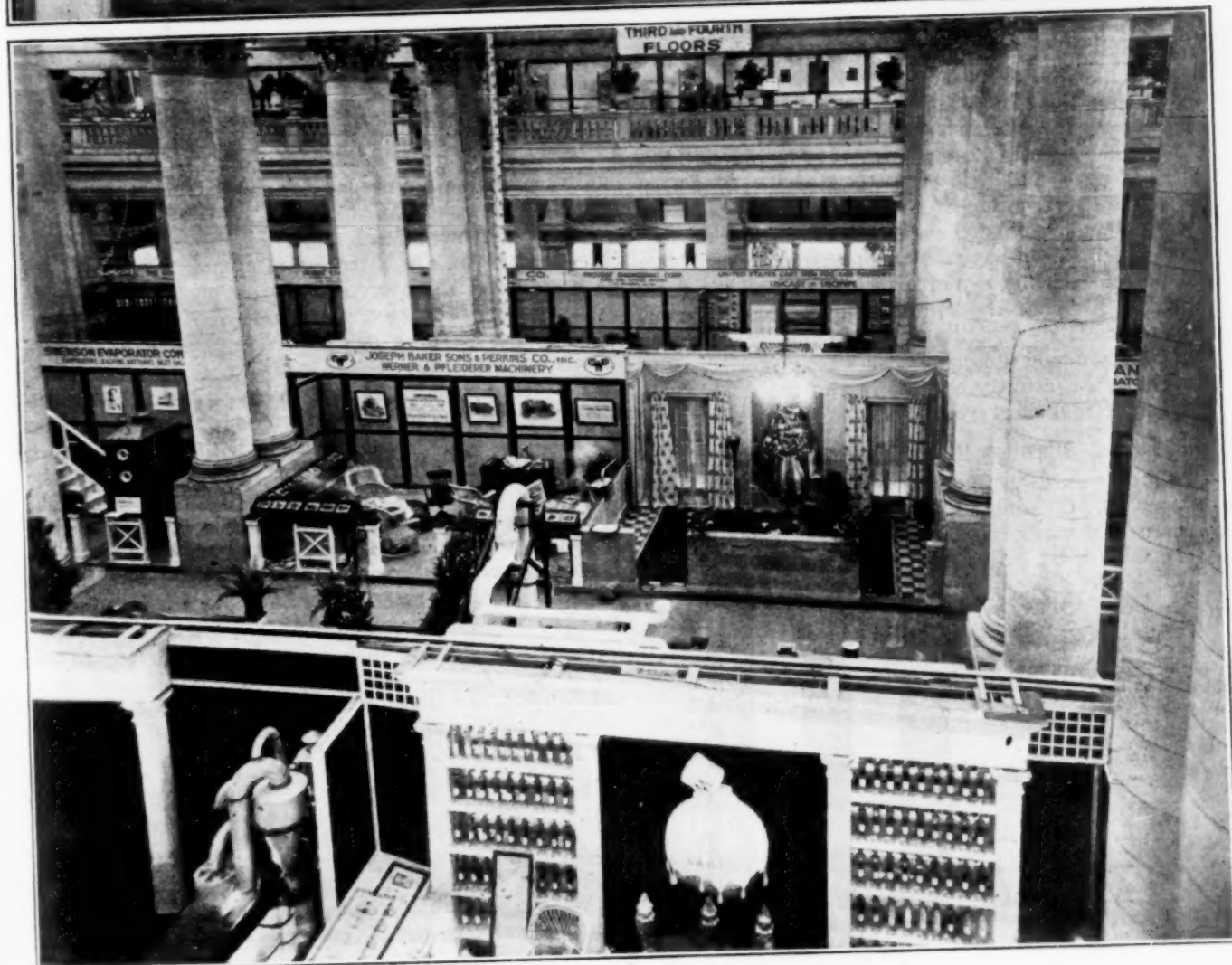
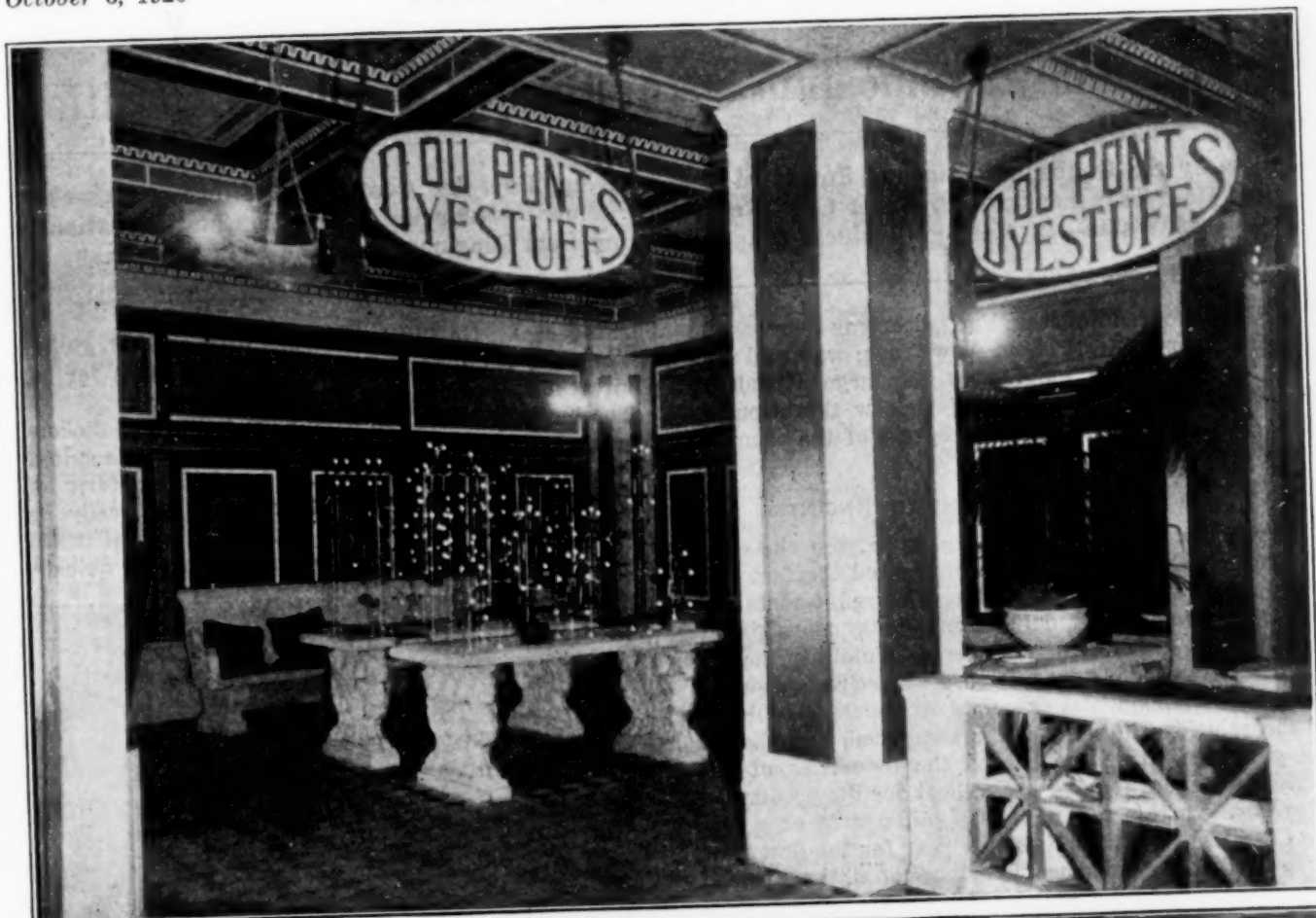
Improvements in the design of analytical balances have led to the development of Eimer & Amend's new type 8A balance. By making the balance beam of aluminum the weight of the beam has been reduced to one-third of its former value. The stirrups will not fall even when the pan is jarred or touched. The bows are reinforced so that they do not tend to "give" under load.

An approach to the scientific measurement of color values is made in the Eastern Kodak Co. colorimeter. It resembles a telescope in appearance, an image of the colored object being formed in one half of the field of vision. The other half is illuminated by a beam of light which is standardized by passing through a tungsten-to-daylight filter. Four special absorption wedges are provided which may be moved across the path of the light by small knobs sliding on a scale graduated from zero to 30. The three upper wedges cut out the green, blue and red rays, respectively, from the standard light, while the lower or neutral wedge is used for varying the intensity. When a color has been matched by suitable manipulation of the wedges, the positions of the knobs on the scales are read off, giving a numerical expression for the color value. A series of oil paintings carefully prepared with pigments of varying optical properties attracted popular interest. Thus, when viewed through the special color filters provided, a summer landscape became transformed into a winter scene, and words and figures invisible to the naked eye appeared upon the other paintings.



NATIONAL ANILINE & CHEMICAL CO., INC.





Fuel Economy Symposium at the Sixth Chemical Exposition

Address by the Chairman—Burning Powdered Coal—Saving Fuel by Controlling Chimney Losses—Fluid Heat Transmission—Producer Gas—Refractory Cement—Reducing Conduction and Radiation Heat Waste—Increasing Conduction and Reducing Fuel Consumption—The Dressler Kiln

THE program of the Fuel Economy Symposium held Sept. 21, 1920, in New York, was well provided for, and judging by the large attendance the subject of fuel economy enjoys now the attention its importance in the efficient progress of the chemical and allied industries deserves.

FUNCTION OF THE COMBUSTION ENGINEER

In opening the meeting R. C. Beadle, the chairman of the Fuel Economy Section, emphasized the fact that if the chemical engineer is dealing with refinements, the perfection of processes, doing things today more simply that were done laboriously yesterday, fulfilling the demand for tremendous production, he must recognize one thing as a fundamental principle on which to build all of the solutions in which he is concerned, and that is the great driving force behind the industries of the world, the generation and use of heat for the production of power. In this regard it is significant to note that the Chemical Exposition has this year for the first time recognized the tremendous importance of all those things which go to make for better efficiency by setting aside a day to be devoted to discussions on fuel economy by the brothers of the chemical engineers known as combustion engineers.

He dwelt at length on the fact that America, as well as the rest of the world, is faced with one of the most acute problems—namely, a shortage of many millions of tons of coal—and that too little attention has been paid to the conservation of the natural fuel resources, the very abundance and the apparent inexhaustible supply of which has cheapened them in our eyes. This must be remedied by a more efficient use of the fuels available. It is for the combustion engineer to point out better methods of doing the thing that was done in a cumbersome and uneconomical way yesterday, and thus relieve this country and the rest of the world from the crisis of fuel shortage.

BURNING POWDERED COAL

In a paper on "Burning Coal at 100 per Cent B.t.u. Efficiency" W. O. Renkin strongly advocated the use of powdered coal as being the most efficient method of



FIG. 1.

burning coal. He illustrated this with a chart giving the relative B.t.u. recovered in the boiler room for 1c. at present fuel prices (see Fig. 1).

The burning of coal on hand-fired grates and stokers requires normally great excesses of air to secure suited flame conditions; in burning coal in powdered form all excess air is always under control and can easily be eliminated, when necessary, as the powdered coal is fed into the furnace in a cloud where each particle quickly

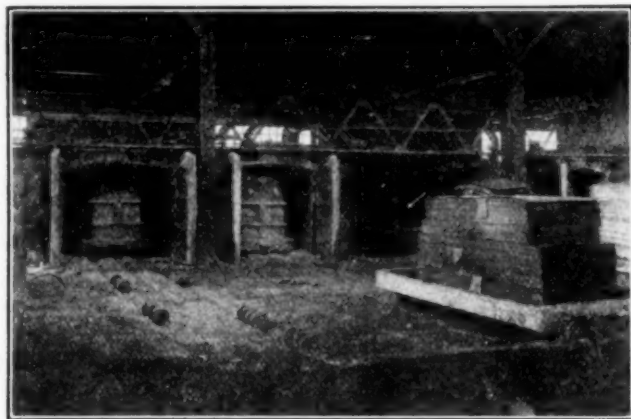


FIG. 2. POWDERED COAL-FIRED SHEET BOX ANNEALING FURNACE

unites with the air needed for combustion, thus securing the greatest B.t.u. efficiency.

The early mechanical difficulties in connection with the preparation and distribution of powdered coal have been commercially overcome, thereby making it possible to use much of the low-grade coal heretofore wasted, and coal having as high as 25 per cent ash can be used easily and efficiently.

Powdered coal can be said to have passed the experimental stage, and by proper furnace construction higher CO₂ percentages can be had than with any other fuel.

Mr. Renkin, after describing and illustrating the Quigley system of powdered coal firing, mentioned that in one plant the fuel consumption per ton of material produced was reduced from 244 lb. hand-fired to 60 lb. powdered coal-fired, using a coal of much poorer grade in powdered form; and in another plant the reduction was from 440 lb. stoker-fired to 185 lb. powdered coal-fired. He also stated that the coal does not receive the air necessary for combustion until it is delivered into the furnace, and that the coal is burned under minimum velocity insuring clean working chambers and practically 100 per cent B.t.u. efficiency.

SAVING FUEL BY CONTROLLING CHIMNEY LOSSES

F. F. Uehling presented a paper on "Saving Fuel by Controlling Chimney Losses." He stated rightly that no matter how the fuel we use is consumed and no matter what kind of fuel is burned, whether solid, powdered, liquid or gaseous, the biggest loss is always due to the

heat energy wasted up the chimney. The chart showing what becomes of the total heat in the coal (Fig. 3) is a fair example of what takes place in the great majority of boiler rooms.

The loss up the chimney, which is always the largest individual loss in any plant, depends for its magnitude

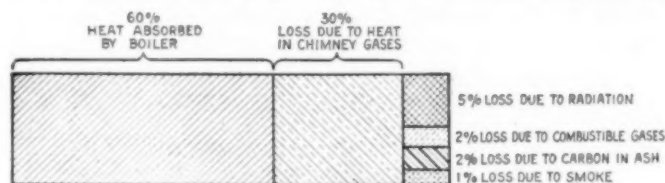


FIG. 3.

on three factors. They are, in order of importance, first, excess air in the products of combustion, which is determined by the percentage of CO_2 ; second, the amount of unburned fuel in the products of combustion, the magnitude of which is indicated by the percentage of CO ; third, the temperature of the products of combustion, which can be determined with an ordinary flue gas thermometer inserted in the last pass just before the gas enters the stack.

The excess air in the products of combustion results in loss greater than that from any other source. Even in fairly good practice about twenty-five tons of air is used to burn one ton of coal instead of the twelve theoretically required, and in the more poorly operated plants this amount is often doubled. Twenty-five tons represents a lot of air. Under normal conditions, it occupies a space nearly 16,000 times as large as the coal which it consumes. Stated in another way, if the floor of a room were covered with coal to a depth of 1 ft.,

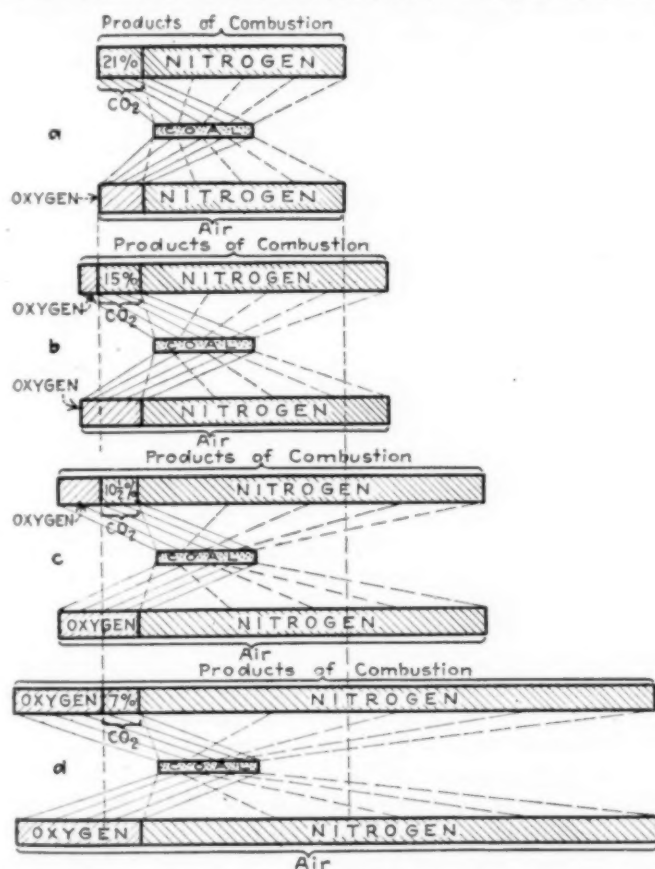


FIG. 4. CHART SHOWING THE HEAT WASTED UP THE CHIMNEY DUE TO EXCESS AIR

(a) Theoretical supply of air, (b) 40 per cent excess air, (c) 100 per cent excess air, (d) 200 per cent excess air.

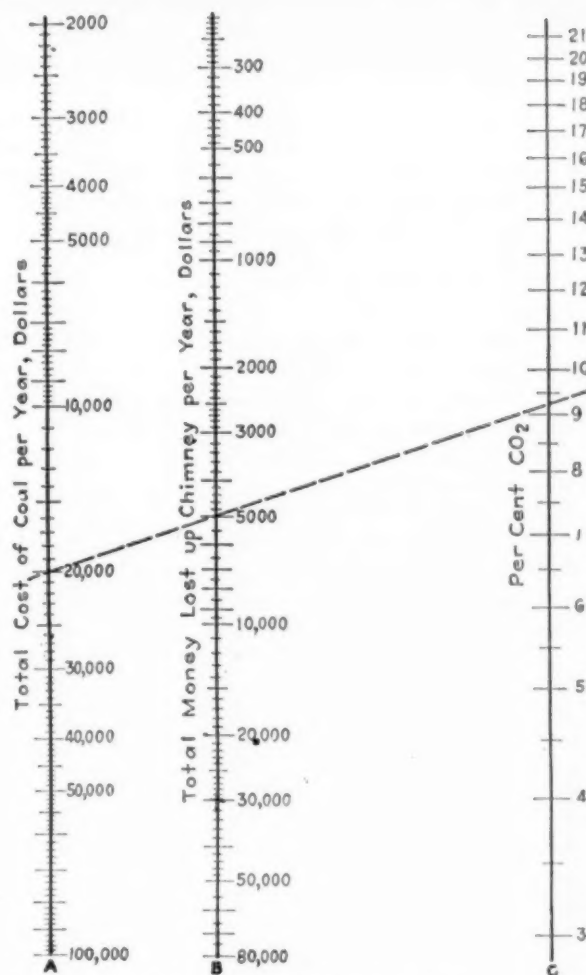


FIG. 5. FUEL WASTE CHART

Relation between cost of coal, percentages of CO_2 in the gases of combustion and the amount of money lost up chimney.

Example: In a plant using \$20,000 of coal per year the average CO_2 percentage is 9.3. To find the amount of money lost up chimney join the point \$20,000 with 9.3. The intersection point \$5,000 gives the loss.

the ceiling would have to be three miles high in order for the room to contain as much air as is generally used to burn that amount of fuel. The fact that so much air is consumed in burning one ton of coal is not realized by the fireman, and the important relation which this huge mass bears to fuel economy is generally not given sufficient thought by his superiors. Although air costs nothing and is available in unlimited quantities, when used to burn fuel in excess of what is required, as is the case in the average plant, it becomes one of the most expensive raw materials. The conditions when excess air is used are well illustrated in Fig. 4.

The other loss up the chimney—namely, that due to unconsumed fuel in the products of combustion—is usually not so serious. The average loss from this source can safely be estimated as less than 2 per cent.

The third variable—namely, the temperature of the products of combustion as they enter the stack—is one over which the firemen have no control at all. The practice of merely instructing the firemen to keep the percentage of CO_2 as high as they can has led to surprisingly good results.

REDUCING CONDUCTION AND RADIATION HEAT WASTE

The paper by S. L. Barnes on "Reducing Conduction and Radiation Heat Losses" dwelt at length on the development of insulating bricks composed of diatoma-

ceous earth (kieselguhr). To increase the heat-insulating efficiency of the natural earth and to obtain a more uniform product, the raw material is pulverized, mixed with finely ground cork, molded into brick form and then fired. The cork is burned out, and the small spaces left, being filled with air, increase the heat-insulating efficiency of the finished product. This manufacturing process also eliminates the strata, or layers, found in the natural earth and thus gives the brick uniform strength in all directions under compression.

Compared with firebrick or ordinary red brick, the two materials most commonly used in the construction of high-temperature equipment, it has been found that insulating bricks of diatomaceous earth are fully ten times more efficient as non-conductors of heat.

The fuel savings that result from the use of insulating brick in various kinds of equipment can be computed from the fact that theoretically one 4½-in. course of insulating brick will save from 60 to 75 per cent of the heat ordinarily lost by radiation from the average boiler setting, furnace, etc., and such information as has been obtained from users of the material shows these figures to be substantially correct and quite conservative.

INCREASING CONDUCTION AND REDUCING FUEL CONSUMPTION

In a paper on "Increasing Conduction and Reducing Fuel Consumption" W. R. Van Northwick described the detrimental influences of soot and feed water scale on boiler efficiency.

The soot is not necessarily unconsumed carbon but is more often ash. Its removal by mechanical methods is a comparatively simple task with a properly designed and installed soot blower. The feed water scale is a much more complicated problem, due to the character of the substance as well as the location in the boiler in which it forms. This scale is not only an excellent heat insulator, but is also the cause of numerous more or less serious boiler failures.

He passed briefly in review the various treatments developed with the idea of purifying the feed water so as to eliminate the scale incrustations, such as: Filtration, external heat treatment, external chemical treatment, combined external heat and chemical treatment and internal chemical treatment. He concluded with the statement that mechanical scale removal is in the end the most economical and efficient method for freeing the boilers of scale incrustations.

FLUID HEAT TRANSMISSION

Alexander B. McKechnie presented an interesting paper on "Fluid Heat Transmission." The advantages of transmitting heat by means of a high boiling point fluid have been known for many years. High flash point oil, being easily obtainable, was naturally the fluid chosen.

In the design of a fluid heat transmission system there are five main factors, each one of which requires the most careful study. They are as follows: Design of heater or absorber, type of circulating pump, type of system, quality of circulating oil and construction of pipe lines.

Fluid heat transmission installations have been made in a number of plants for asphalt roofing, rubber covered electric wire, hard wax products, etc. These systems can be built in sizes ranging from 50,000 to 1,500,000 B.t.u. per hour.

The efficiency of a properly designed and engineered system compares favorably with that of high-grade boiler construction. If the fluid velocity through the tubes, the gas velocity and its passages and the furnace are correctly computed, then most satisfactory results will be obtained. Systems are operated today after a period of over three years with absolutely no carbon in any part of the heater, and the tubes, both internal and external, appear to be in the same condition as they were on the day when first put into service.

PRODUCER GAS AND THE MODERN MECHANICAL PRODUCER

W. B. Chapman gave a very interesting and profusely illustrated lecture on "Producer Gas and the Modern Mechanical Producer," in which he passed in review different American and foreign types of gas producers and dwelt especially on their mechanical operating features.

REFRACTORY CEMENT

F. W. Reisman made a plea for the use of plastic high-temperature cement—hytempite—in place of fire-clay, in a paper on "Refractory Cement: Life Insurance for a Furnace." He described with illustrations the ways of applying the cement and the efficient results obtained by its use.*

THE REASON FOR THE FUEL SAVING IN THE DRESSLER KILN

Conrad Dressler in a paper on "The Reason for the Fuel Saving in the Dressler Kiln" stated that the saving of fuel in this kiln is by no means its main advantage. Its great advantage is that it lends itself to the realization of a time and heat and atmosphere curve which is the ideal one for each material treated, and that this curve can be maintained constant so that every article that passes through the particular kiln in which it has been set receives the same treatment as every other. In this way all the defects which arise from variations in heat treatment are eliminated.

The kiln is in the form of a tunnel which may be anything from 100 to 300 ft. long. The goods enter cold at one end and come out fired and cooled at the other. The heat is applied generally in the form of burning gas at a point about two-thirds of the tunnel's length from the mouth.

The gas does not burn among the goods, but in two independent chambers, which run on either side of the goods track for the whole length of the heating up and firing zones. The burning gases travel in these chambers in the direction opposite to the goods and the products of combustion are taken off generally at a temperature not exceeding 400 or 500 deg. F.

After the goods have reached the hottest zone and have been completely fired, they pass through a cooling zone about one-third of the total length of the kiln. Here they meet a stream of cold air, which is drawn through them and later into the combustion chambers. The heat which the air thus recovers from the goods is utilized in lieu of that much fuel.

These kilns are used not only in the ceramic industry but also for making copper oxide and lead oxide, for the conversion of gypsum stone to plaster of paris, and lately they have been applied to the interesting problem of coal carbonization.

*See "Cementing Jamb Joints," CHEM. & MET. ENG., Aug. 1, 1919, pp. 153-154.

Industrial Management and Materials Handling

Problems in Industrial Management—Preliminary Report of the Progress of the American Coal-Tar Industry During 1919, Subject to Revision Upward Upon Publication of the Final Report by the Tariff Commission—Conveyors and Conveying

IN THE introductory address at the Industrial Management Symposium, the chairman, Ellwood Hendrick, pointed out how the doctrine of relativity could be applied to the problems of management. Automatic flow sheets of authority which seem perfect on paper fail in practice because attention has been centered solely on the functions of departments. The lines of relativity between each department and factor and the head have not been sensed and made alive, nor has proper provision been made for quick response to initiative on the one hand and defect on the other.

Harrington Emerson explained briefly his universal formula for costs and showed the value of making cost analyses in greater detail than is usually done.

"Research in Industrial Conservation" was the title of an interesting paper by Dr. H. E. Howe of the National Research Council.

American Coal-Tar Chemical Industry: Its Progress During 1919

BY GRINNELL JONES*

A YEAR ago the annual census of dyes and other coal-tar chemicals, prepared by the Tariff Commission, was published on June 11. This year it has been unavoidably delayed owing to the fact that it is the year in which a general census of manufactures of all kinds is being taken by the Bureau of the Census. In order to avoid having two different branches of the Government each send its questionnaire to every manufacturer, it was arranged that the collection of the reports should be undertaken by the Census Bureau, whereas the tabulation and interpretation of the reports on dyes and coal-tar chemicals would be done by the Tariff Commission.

The Census Bureau, having a large staff of men covering the whole country and visiting every house and factory, has secured reports from a number of small manufacturers who were unknown to us. However, the collection of the reports has been much delayed by the co-operative arrangement, since the collection of these dye reports is from the point of view of the Census Bureau merely a small part of a vastly greater task. Even at this date the reports of over a dozen firms have not yet been turned over to the Tariff Commission, and I cannot therefore at this time give any final figures, as I had hoped to be able to do. However, the missing reports are all believed to be of small firms making a few small specialties only. I am confident that our records are sufficiently complete to show clearly the progress made during the year, but any figures given are subject to revision upward.

ADEQUATE SUPPLIES OF RAW MATERIALS AVAILABLE

The Geological Survey has recently reported that the production of byproduct coke and the byproducts

obtained therefrom during the year 1919 shows a slight decrease, as compared with 1918. This was due to labor troubles in the steel and coal mining industries and to railroad congestion. There appears to have been a small decrease in the amount of tar distilled and a large decrease in the output of pure benzol, and especially of pure toluol. This means that a much larger proportion of the output was sold as mixtures for solvent purposes or as motor spirit instead of in the purified condition. Of more significance in considering the future of the coal-tar chemical industry is the fact that the productive capacity of the byproduct coke ovens in the United States increased 17.2 per cent during 1919. There is no question that, with the possible exception of anthracene, adequate supplies of the fundamental raw materials of coal-tar origin will be available from American sources for the growth of the industry.

THE ANTHRACENE PROBLEM

In the case of anthracene considerable progress has been made during the past year, but the problem of securing adequate supplies is still unsolved. In 1918, the anthracene content of the crude anthracene produced was about a quarter million pounds, but very little of this was refined. In 1919 the output of crude anthracene was about three times the 1918 record, and a much larger fraction of it was refined than in 1918. Although this shows great and encouraging progress, nevertheless a much greater increase in output must be secured before there will be enough American anthracene available to supply the American demand for alizarin and vat dyes. It may be roughly estimated that the 1919 production of crude anthracene contained less than one-fifth of the amount of anthracene which would be required to supply the American needs. The fundamental difficulty is not primarily an actual lack of anthracene in the tar or purely technical difficulties in its recovery, but rather the fact that its removal leaves the pitch so hard that it does not find a ready market under American conditions. In England and Germany large amounts of hard pitch were used for the briquetting of coal dust and coke breeze, but this industry is very little developed in the United States. Any method of recovering anthracene which seriously disturbs the marketability of the other larger fractions of the tar, especially the pitch, would make the anthracene so expensive that the dyes derived therefrom could not be made on a competitive basis.

This problem of securing supplies of anthracene adequate in amount and at a cost which is not prohibitive is perhaps the most important and most fundamental problem still awaiting solution in this industry. Whether it will be solved by the tar distillers or by the development of a synthetic process for making anthracene or anthraquinone cannot be determined at the present time. Active work on this problem along

*Chief Chemist, U. S. Tariff Commission.

both lines is now under way and the progress already made is encouraging.

INDUSTRY NOW ON PEACE BASIS

As was to have been expected, there was a large decrease in the output of several intermediates needed primarily for explosives. This is most noticeable in the case of phenol, which showed an enormous production—106,000,000 lb.—in 1918, but fell to less than 1,500,000 lb. in 1919, nearly all of this being obtained from coal tar. A less conspicuous case is the decrease in the output of monochlorbenzol from 20,500,000 lb. in 1918 to a little more than 4,000,000 lb. in 1919. There was also a considerable decrease in the output of several intermediates required for making dyes used for army uniforms; for example, there was a 25 per cent decrease in the output of *m*-toluylenediamine, which was used for making a khaki dye for cotton uniforms, and a 90 per cent decrease in meta-nitraniline, which was used for making a khaki dye for wool uniforms. These examples mean merely that chemical skill and chemical materials were no longer needed to make explosives or other military supplies, and henceforth could be devoted to our peace industries. It is my purpose today to give some typical examples of the progress of the American coal-tar chemical industry under peace conditions.

PRODUCTION OF INTERMEDIATES

A comparison of the intermediates produced in 1918 and 1919 shows a considerable increase in the number of intermediates and substantial increase in amount in many cases. In 1919 there were about 225 different intermediates produced, against about 140 in 1918. The new intermediates are, of course, comparatively difficult to make, but were needed for dyes and medicinals of the better class. Among these new intermediates may be mentioned brombenzol, dibenzylaniline, dichloraniline, nine new sulphonic acid derivatives of naphthol or naphthylamine, beta-oxynaphthoic acid, and five new anthraquinone derivatives.

As a rule, the intermediates for which there is the largest demand and whose manufacture had been well established by 1918 show comparatively little change in 1919. Thus, nitrobenzol gained 11 per cent, the 1919 output amounting to about 42,500,000 lb.; the output of aniline was about 24,500,000 lb., a gain of 1 per cent; paranitraniline, with an output of about 1,300,000 lb., lost 1 per cent, and beta-naphthol, with an output of about 5,000,000 lb., dropped 6 per cent. The output of H acid increased from a little less than 3,000,000 lb. in 1918 to about 4,000,000 lb. in 1919; on the other hand, the output of dimethylaniline fell off about 15 per cent, amounting to 3,500,000 lb.

INCREASE IN OUTPUT OF INTERMEDIATES DERIVED FROM TOLUENE

There are many notable increases in the output of individual intermediates, especially noticeable in the case of intermediates derived from toluol or from anthracene. The output of U.S.P. benzoic acid increased from about 173,000 lb. in 1918 to over 600,000 lb. in 1919, with a drop in valuation from \$3.07 to 74c. per lb. Ortho-toluidine increased from 639,000 lb. to a little over 1,000,000 lb., and para-toluidine from about 200,000 lb. to over 575,000 lb., with a drop in valuation per pound to nearly half the 1918 figures. The general

increase in the output of intermediates derived from toluol is, of course, due to the relaxation of the restriction in the use of toluol during war times.

COMPLEX INTERMEDIATES

There are also many examples of a big increase in the production of intermediates which are difficult to make but are required for dyes of the best quality. A good example of this kind is amidonaphthol sulphonic acid 2:8:6 (gamma acid), which was made in 1918 by a single firm, but in 1919 by five firms, with an output of over 155,000 lb., valued at \$667,000, which is many times the 1918 output. These five firms used this gamma acid to make nearly half a million pounds of oxamine black—an important direct black which can be developed. Moreover, gamma acid also went into diamine fast red F, neutral gray G, and columbia black FB—all of them important direct cotton dyes of faster type.

Other intermediates whose output increased substantially include metanilic acid, with an output during 1919 of 450,000 lb.; ethylbenzylaniline, which served for the manufacture of acid violet; Michlers ketone (280,000 lb.), used mainly for the important dye auramine; thiocarbanilide, (2,250,000 lb.), used as an accelerator for vulcanizing rubber; naphthylamine sulphonic acid 1:5 and 1:8; and amidonaphthol sulphonic 1:2:4 (about 900,000 lb.), which are important naphthalene derivatives.

ANTHRACENE DERIVATIVES—ANTHRAQUINONE

The progress among the anthracene derivatives is of especial interest. Here, unfortunately, definite figures cannot be given without revealing confidential information. In 1919 there were ten intermediates derived from anthracene, against only five in 1918. The output of anthraquinone, which is the most important because it serves as raw material for the manufacture of nearly all other intermediates derived from anthracene, was about ten times as great in 1919 as in 1918.

PRODUCTION OF DYES

The total output of all dyes increased about 8 per cent over 1918, or to a little more than 63,000,000 lb. valued at about \$67,000,000. The average value per pound was \$1.07, which is just the same as shown by the 1918 census. The average quality of the dyes has, however, improved considerably, due to a partial replacement of many of the cheaper dyes by others of a more satisfactory character. The consumer accordingly received better value for his money in 1919 than in 1918.

The production of basic dyes for 1919 was over 4,000,000 lb., an increase of more than 1,000,000 lb. as compared with 1918. The production of magenta, victoria blue, malachite green and bismarck brown more than doubled, while auramine nearly trebled. There has been a conspicuous increase in the production of rhodamine B.

The production of direct dyes was about 14,500,000 lb., an increase of 2,000,000 lb. as compared with 1918. About half of this total was direct deep black EW. Conspicuous changes include large increases in the output of chrysophenine, primuline, oxamine black, diamine rose, and the first appearance of diamine fast red F.

The production of mordant dyes during 1919 was over 3,100,000 lb., which is about 2,300,000 lb. less than the output of mordant dyes in 1918. This decrease is due

principally to a diminished production of alizarin yellow GG and R of more than 2,000,000 lb. Mordant dyes available in 1919 in considerable although inadequate amounts included alizarin, alizarin saphirole and other alizarin derivatives, and a considerable number of fast mordant dyes for wool dyeing and mordant printing.

The production of acid dyes for 1919 was over 14,000,000 lb., about 6,000,000 lb. more than in 1918.

INDIGO PRODUCTION EXCEEDS PRE-WAR IMPORTATION

The production of indigo, 20 per cent paste, reached 8,863,824 lb., valued at \$5,233,719. This exceeded the 1914 importation by 356,465 lb. and the 1918 production by 5,779,936 lb. Several indigo derivatives were placed on the market. Four other vat dyes were made on a commercial scale during 1919, but the output was only a small fraction of the pre-war consumption. However, fundamental progress has been made in this field.

The total production of sulphur colors for 1919 was over 17,000,000 lb. This was about 6,000,000 lb. less than that for 1918. This was largely due to a decrease of about 8,000,000 lb. of sulphur olive and khaki dyes required in the war period for cotton uniform cloths. Sulphur black production in 1919 (14,250,000 lb.) was about 2,000,000 lb. more than that for 1918.

COAL-TAR MEDICINALS—PHOTOGRAPHIC DEVELOPERS

Among the coal-tar medicinals there has been a substantial increase in the output of many items already well established in 1918, including aspirin, acetphenetidine, arsphenamine, guaiacol and methyl salicylate. Moreover, a considerable number of new products have been introduced on a small scale.

In the case of photographic developers of coal-tar origin, there was a decrease of 30 per cent in the output of hydroquinone, to about 200,000 lb., valued at nearly \$500,000. On the other hand, the output of metol increased more than five times, to nearly 60,000 lb., and para-amidophenol increased about 7 per cent, or to over 130,000 lb.

The many difficult problems in readjustment from war conditions to peace conditions have been met with encouraging success. The achievements of American chemists in these industries furnish an excellent basis for optimism as to the future.

Conveyors and Conveying

W. T. Spivey gave a very good talk, illustrated by a number of views and moving pictures, on "Cost Cutting With Conveyors." He emphasized in many ways that because a conveyor did good work in a certain instance, it could not be expected to do the same work in quite another. Proper application is the prime essential. A spiral chute which handles eggs, either in cases or small paper cartons, would smash tote-boxes filled with hardware. Certain sacked materials could be carried up a slope so steep that almost any other sort of container would slip back. Too often light conveyors for sacked cement are made to handle cotton bales, or flexible swinging conveyors installed on warehouse floors full of building posts. Failure and disappointment naturally results, all because a good machine has been put at work it is not adapted for. Ultimate economy will be had in insisting that the so-called "practical" man take advice from the engineer, in recognizing that a conveyor is a machine to handle certain definite things from one place to another, in buying conveyors which

are strong enough for the duty expected and then seeing to it that they are not overloaded. Portable machines are especially liable to abuse—they must be light, else the men would rather handle the material than the conveyor, yet the constant temptation is to put a far bigger load on a good machine than is safe.

Use of Pulverized Lignite for Fuel in Australia

A new Australian syndicate has been registered at Melbourne "to mine, process and deliver to prospective customers throughout the commonwealth" pulverized lignite, or brown coal, which, it is claimed, can be used for steam generation or metallurgical purposes with most satisfactory results. The syndicate controls various brown-coal deposits throughout the State of Victoria, said to contain over 250,000,000 tons, and mining operations are well under way.

Many novel features have been introduced in mining and air-drying the lignite, as well as in the process of pulverizing and burning. The plans for the entire work were prepared by Roy N. Buell, of San Francisco, Cal., chief consulting engineer, and the plant which the company recently built at Abbotsford (a suburb of Melbourne) was erected under his personal supervision.

The most striking improvement in this new method of treating lignite, which is known as the "Buell system," is the means of air-drying at the mines, whereby the moisture content is reduced from 50 to 25 per cent in seven days. Briefly described, the process is as follows:

The lignite is mined in either shafts or open cuts, the coal crushed on the spot to egg size, then hoisted to the air-drying tipples at the surface by bucket conveyors. After drying about seven days, the coal is relieved of practically half of its moisture content and is ready for final treatment. This final process, which should be undertaken near the place where the fuel is to be used, consists of again crushing the coal—to about $\frac{1}{2}$ -in. mesh—after which it is passed through a rotary drier, where the moisture content is reduced to about 10 per cent. The fuel is then pulverized, separated by air, and stored in bunkers.

To use it is blown through pipes, where it is mixed with air in quantity 10 per cent in excess of requirements and ignited at the tip of an adjustable burner, which enables the length and width of the flame zone to be most accurately gaged. Boiler tubes and baffles are kept clear of ash by soot blowers and suction conveyors carry off the ash to any desired place of disposal. Three per cent of the power generated is required to operate the plant, and one experienced man can fire a whole battery of boilers or kilns.

Under test the boiler efficiency was 80 per cent, the furnace efficiency 78 per cent.

Susceptibility of Women to Lead Poisoning

At an inquiry held in Manchester, England, into the death of a girl employed at an accumulator works, it was stated by Dr. H. Heap, of Manchester University, that in females the incidence of lead poisoning was greater than in males, according to *The Engineer*, London. In this connection it is interesting to note that as the outcome of a recommendation on the subject made at a conference of the International Labor Organization of the League of Nations, held at Washington in November last, a bill has been presented to Parliament to make provision for the better protection of women and young persons against lead poisoning.

Chemical Engineering Symposium

Meeting of the American Institute of Chemical Engineers at the Sixth National Exposition of Chemical Industries—Papers Presented on Pyrolysis, Nitration, Recoverance, Physical Constants and Canada and the Chemist

THURSDAY, Sept. 23, was set aside as Chemical Engineering Day. The paper program was well attended in spite of the hum of machinery all about, which was calculated not to disturb men immune to plant noises.

The addresses were opened by the president of the Institute, David Wesson, with the following introductory remarks on "Some Duties of Chemical Engineers":

"The wonderful Exposition which we are attending may be considered largely due to the work of the chemical engineer. If it had not been for the chemist, there would not have been anything to show. It took the chemical engineer, however, to translate laboratory results into accomplishment, and it does not seem as though we were taking too much to ourselves as chemical engineers in claiming considerable credit for the many useful and beautiful things now being shown in this great building.

"As I look upon this wonderful Exposition, I cannot but feel that it is another milestone in the path of progress of our profession. The text 'By their works thou shalt know them' seems particularly applicable.

"It is unnecessary to expatiate on the many magnificent exhibits scattered throughout the Exposition. They speak more eloquently than words of the triumphs of applied chemistry, which is nothing more than another name for chemical engineering.

DUTIES AS CITIZENS

"We all think we have done very well and have performed real service to the special industries in which we are engaged, but we must not for a moment lose sight of the fact that the training which has enabled the chemical engineer to contribute to the welfare of his country in furthering the development of its material resources can be applied to equal advantage in furthering the country's political and economic welfare. While doing our duties as chemical engineers, we must not lose sight of our duties as citizens. It is unnecessary to state what we all know, that this is a time of readjustment. Our country has just been passing through an era of reckless extravagance unparalleled in the world's history. We are confronted on all sides with the high cost of living. It is our duty as chemical engineers to do what we can to see that the government of our country is in the hands of those who will conserve its resources and pass laws that will prevent waste. There are various measures now pending before Congress which are of great interest to us as chemical engineers and as citizens. It is our duty to take an interest in them and to encourage our Congressmen to stand up for them by writing them personally.

"There is a bill now before Congress to consolidate the activities of something like forty bureaus now scattered through several departments of the Government, into a department to be known as the Department of Public Works. Full information will shortly be sent to

every member of the Institute concerning this new reform, and it is hoped that every member will write to his Congressman and ask him to support the bill, which will save many millions of dollars a year in the operation of the Government and incidentally help the taxpayers.

"Patent laws are now pending in which we are all interested. As chemical engineers we should show our interest in these laws by telling our Congressmen what we want and keep after them until we get it.

"We will soon see bills brought up in Congress for drawing a protective tariff wall around our various industries. As chemical engineers and as citizens, it is our duty to study these bills and give to our Congressmen, as far as possible, the benefits of our knowledge and experience, to the end that whatever is done with the tariff, it may be done in the right direction and along scientific and economic lines.

"Furthermore, if in order to accomplish our duties as citizens, it should be necessary for us individually to go into politics, we must not shirk our duties, but put on our gas masks and enter the field which we preferably would avoid.

"There is another thing which we can do as individuals. As chemical engineers we are, naturally, economists when it comes to the proper operation of industries. As individuals, it is our duty in this readjustment period to set the example of thrift. We can if we wish, follow the example of one of our Presidential candidates who says he makes one pair of shoes last two years, or we can emulate the case of the Irishman who, when told that his coat was too short, said it would be long enough before he got another one. The high cost of living of the present day is due to extravagance, and anything which we can do to curb it will be a true service to our country."

The Whitaker-Pritchard Process of Destructive Distillation

BY THOMAS W. PRITCHARD

PERHAPS no problem of a technical nature involves as many unknown quantities, both chemical and physical, as pyrolytic distillation. In the research on the Whitaker-Pritchard process we have, we believe, opened the door to one solution by providing a process whereby destructive distillation may be carried on under definite control. It is conceded that the all-important factor in destructive distillation is control of the temperature at all times. The yield and the quality of the products produced are directly dependent on this. Destructive distillation of organic material such as wood, bone, coal, shale and industrial wastes as generally carried on involve rather high temperatures and practically no definite thermal control. In many cases the variations in the distilling chamber will vary

several hundred degrees in temperature, and the result of this sort of treatment is uneven temperature throughout the charge, material close to the hot walls being broken down before the center of the charge has been changed. This results in a mixed distillate of an inferior quality as well as an excess of fixed gases owing to the actual destruction of the distillates themselves.

There is the additional problem of removing the vapors of distillation from the chamber, and in ordinary methods this is accomplished by the generation of enough pressure from the process to force the vapors through the condenser, which, to say the least, makes the process slow. The use of vacuum in high-temperature work is almost impossible and as a matter of fact is not, to my knowledge, successfully employed. The old method is also wasteful as regards heat used, as excessive temperatures must be used because of poor distribution.

It was to overcome these defects that the present process was devised, and I will try to give you a brief description of the application of the principle of circulation as applied to this work.

RETORT ARRANGEMENTS

The material to be distilled is placed in a closed retort. This retort may be either vertical or horizontal, depending on the class of material. The retort is sealed and heat is applied to the outside walls. An outlet pipe from either top or bottom of the retort leads to a condenser. So far we follow the old method, but from the condenser the vapors, or such as are not condensable, are carried to a blower or fan, and from there are forced through a super-heater and returned to the retort, passing through the distilling mass and by means of their positive carrying power and sweeping effect they not only distribute the heat units through the mass but act as a scavenger and carry out the vapors formed as rapidly as is desired.

The rate of flow of the gases through the retort serves as a direct means of temperature control, without regard to the heat applied to the outside walls of the retort. The cycle of circulation is kept up until by our temperatures and flow of distillates we know that the operation is completed. If desired the fires can then be drawn and the circulation still continued and we get a rapid and even cooling of the charge, which allows us to remove it in much less time than we could otherwise do.

FINDINGS FROM EXPERIMENTAL TESTS

The benefits from this method as applied to this work may be summed up as follows: (1) There is a definite temperature control during the entire operation. (2) The time of distillation has been reduced at least one-third. (3) The quantity of distillates has been in every case increased and in some cases this increase has been enough to pay for the entire operation. (4) The quality of the distillates is improved and they are uniform and can be produced of a definite standard, which is impossible by the old method. (5) The distillates are in all cases much more easily refined and the refining losses are less. (6) By means of temperature control some unusual facts have been developed, and I am going to cite one instance. We distilled a charge of Tennessee cannel coal at a temperature of 500 deg. C. with the result as follows:

RESULT OF RUN NO. 31

Cannel coal, 300 lb. Maximum temperature of distillation, 500 deg. C.

	Per Cent		Per Cent
Coke.....	65.33	Ammoniacal liquor.....	3.64
Tar oils.....	19.86	Gas.....	11.17
Tar oil recovery per 2,240 lb., 56.46 gal.			
	Gal.		Gal.
Benzene.....	1.73	Distillate over 200 deg. C., in-	
Toluene.....	0.49	cluding tarry acids under	
Solvent naphtha.....	34.95	200 deg. C.....	19.29

AMMONIACAL LIQUORS

The water condensate amounted to 9.79 gal. per gross ton and contained 1.506 lb. of ammonia (NH_3), giving a liquor of NH_3 strength of 1.98 per cent.

GAS ANALYSIS

	Per Cent		Per Cent
CO_2	5.2	CH_4	8.8
Illuminants.....	12.8	H_2	10.7
O_2	0.2	N_2	58.4
Sp. gr., 0.464.			
B.t.u.'s per cu.ft. 30 in. Hg. at 60 deg. F., 624.0.			
Cu.ft. per gross ton, 7,075.			

LIGHT OILS FROM GAS

	Gal. per Gross Ton		Gal. per Gross Ton
Benzene.....	0.822	Solvent naphtha.....	0.702
Toluene.....	0.33		

Ammonia (NH_3) content of gas runs 2.60 lb. (NH_3) per gross ton.

This gives 4.206 lb. NH_3 per gross ton. We followed this one with another, using the same coal but holding the temperature at 440 deg. C. The following analysis shows the difference:

RESULT OF RUN NO. 32

	Per Cent		Per Cent
Maximum temperature (deg.)	440 C.	Tar and water.....	25.0
Coke (per cent).....	58.7	Gas.....	16.3
	Gal. per Gross Ton		Gal. per Gross Ton
Tar Analysis:			
Yield.....	71.0	Solvent naphtha.....	4.17
Benzene.....	1.28	Ammonia in Liquor.....	0.98
Toluene.....	1.26		
Ammoniacal liquor, 2.56 per cent.			
Water, 10.24 per cent.			
	Per Cent		Per Cent
Gas Analysis:			
CO_2	2.1	CH_4	12.4
Illuminants.....	12.4	H_2	11.2
O_2	1.0	N_2	57.6
Sp. gr., 0.489.			
B.t.u.'s per cu.ft. 629.0.			
Cu.ft. gas per gross ton, 9,629.			

LIGHT OILS FROM GAS

	Gal. per Gross Ton		Gal. per Gross Ton
Benzene in gas.....	0.95	Solvent naphtha in gas.....	0.354
Toluene in gas.....	0.673		

Ammonia (NH_3) in gas 3.42 lb. per gross ton.

I wish to call your attention to the fact that with the temperature variation of 60 deg. C. we increase the production of toluene from 0.68 gal. per ton to 1.93 gal. per ton; and at the same time we change the amount of solvent naphtha from about $4\frac{1}{2}$ gal. to approximately 35 gal. per ton. The analyses in both cases were made by the same person and were carefully checked. The results indicate that certainly with some materials a perfect check can be maintained on the production of definite fractions by accurate temperature control.

Another feature of this process which opens decided possibilities is the fact that many materials which seem to expand in spongy masses under ordinary distillation methods are perfectly tractable by this, and cannel coal, we may say, is one of these materials, as well as our very rich American shale.

We may also include lignite, for while it does not swell and become spongy, yet when given temperature extremes it becomes almost a powder.

Our experimental work has all been done in a plant holding about 300 lb., but we have by this process treated five tons of material, using a converted 40-bbl. tar still, and our results, so far as temperature control and quality of products are concerned, were equal if not superior to the experimental results. Our first commercial plant has just been erected. This plant will have a daily capacity of twenty tons of bone per day, the products being bone char and oil.

Nitration of Hydrocarbons

BY ARTHUR HOUGH, WALLACE SAVAGE
AND D. J. VAN MARLE

IF THE American dye industry is to prove itself worthy of the fullest support of the American people, it must strive not only to attain but to surpass the highest operating efficiency of this industry in foreign countries. Perfection of those operations that are convertible to the manufacture of munitions of war especially should not be neglected, else the main claim of the industry to tariff protection would be without title.

This is particularly true of the nitration of the benzenoid hydrocarbons, which to the casual observer appears to be simple but upon close study proves to be a knotty problem from the viewpoint of the practical and theoretical chemist. Accounting for the effect of variation in temperature, concentration of mixed acid, cooling and mixing efficiency on yields and reaction velocity is a very different task from writing reactions showing the nitro group replacing the hydrogen in the hydrocarbon. Calculations of reaction velocities based on the simple assumptions of the law of mass action with data on aggregate masses have not given results that can be checked by experiment. Some other reasonable premises establishing an active phase as an entity will have to be formulated before the reaction can be mathematically treated from a chemical dynamic point of view.

SOME FACTORS INFLUENCING VELOCITY OF NITRATION

In the nitration of hydrocarbons we deal with a three-phase system, consisting of two liquid phases and a common vapor phase. Without agitation of any kind there is but a small contact area between the two liquid phases, the hydrocarbon and acid forming two distinct layers, each of which is bounded by a film due to surface tension. The reaction can progress only in the space between or on these contact films and its velocity will depend on the surface tension of the two

phases, the diffusion coefficient of the reactants, the removal of the products of the reaction, thermal conductivity, latent heats of vaporization and several other factors not well understood at present.

As soon as mechanical agitation is applied, conditions are entirely changed. The two liquid phases are thoroughly mixed and the active surface is thereby greatly enlarged. No matter if the reaction is regarded as taking place purely on, between or within the contact surfaces of the two liquids, increased efficiency of agitation and increase of temperature will give a higher reaction velocity, because the former increases the active surface and the latter the diffusion coefficient. The influence of the temperature and mixing efficiency has in the past been thought of as too distinct from the conceptions of the reaction. The influence of the presence of sulphuric acid has been insufficiently explained by stating that it served to bind the water or shift the equilibrium or form an unstable compound with the nitric acid or nitrous oxide, etc.

REACTIVE PHASE

A new premise might be briefly introduced here, as it offers a basis for speculation and will be helpful in visualizing the facts connected with nitration. This is that the substances concerned in the reaction—for example, benzene and nitric acid—each exist in two phases, a liquid and a vapor phase in a state of equilibrium within and through the entire agitated liquid medium. This internal-liquid vapor state of the reacting substances may be regarded as the phase in which the reaction takes place and to which the law of mass action may be applied. The reacting masses will then be quantitatively increased with higher temperatures and concentrations of reagents the same as external-liquid vapor pressure. The nature of the changes in pressure with temperature must be somewhat similar to those of external vapor pressure, characteristic curves of which are given in Fig. 1. The TNT line at the right is an extrapolation and decomposes at the temperatures given. The dotted line starting from 196 deg. C. represents 100 per cent sulphuric acid; fuming acids lie to the left and dilute acids to the right. Sulphuric, 98 per cent, occupies the same position as 2:4-dinitrotoluene. It must be understood that the composition of the vapor phases is not the same as that of the liquid with which it is in equilibrium. As a matter of fact water vapor is the only vapor phase found over dilute H_2SO_4 - H_2O systems at the lower temperatures. The effect of temperature on the phases is indeed a

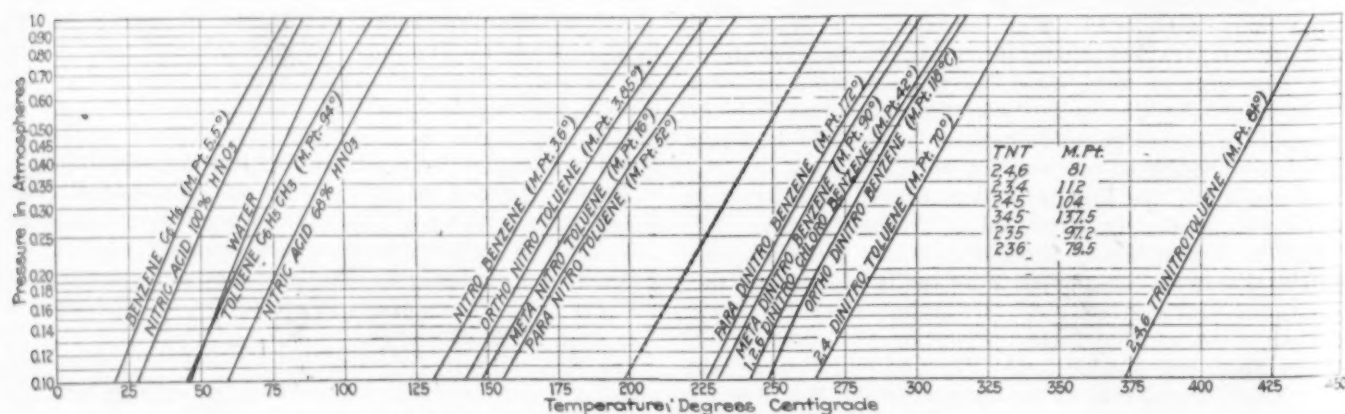


FIG. 1. VAPOR PRESSURE-TEMPERATURE CHART

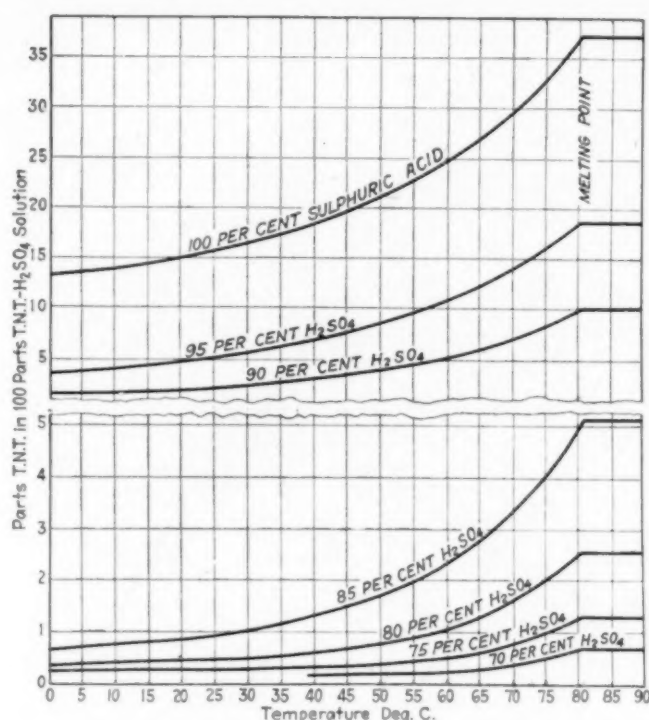


FIG. 2. SOLUBILITY OF TNT IN SULPHURIC ACID

very complicated subject and cannot be entered into in further detail under the present title.

SULPHURIC ACID, SOLVENT FOR WATER AND NITRO COMPOUNDS

The nitration of hydrocarbons is adversely influenced by the presence of water, which is formed during the reaction. Its diluting action in lowering the concentration of nitric acid vapor even in the presence of H_2SO_4 is too well understood to be dwelt upon here. The acceptance of the vapor phase as the reaction phase suggests a simple explanation of the influence of sulphuric acid on nitrations, which it is hoped will be more specific in its applications than any of those presented hitherto.

Other factors influencing the reaction must be considered simultaneously. Thus in aqueous solutions of nitric acid, the concentration of hydrogen and the oxidizing NO_3 group ions have long been thought of as the reacting phase in applying the mass action law. In anhydrous and strong sulphuric acid solutions of HNO_3 , practically no acid hydrogen ions are present and the substance apparently reacts as a hydroxide of the nitro group having the structure $HONO_2$. Mixed acids at nitrating temperatures having a water content lower than 24 per cent do not appreciably attack steel due to the low concentration of the hydrogen ion. This fact is of great engineering importance and makes the use of iron apparatus possible in nitration operations.

The solubility of the nitro-hydrocarbons in sulphuric acid is another factor of primary importance. Figs. 2 and 3 illustrate two typical cases. The increase in solubility with rise of temperature and decrease with dilution of the acid should be noted. It might be stated here that as nitric acid is added to such solutions, the nitro-hydrocarbon becomes less soluble.

NITRATION OPERATIONS

Some of the facts observed in nitration will now be cited by way of illustration. Fig. 4 is a three-coordinate chart having sulphuric and nitric acids and

water percentages as variables. A percentage of any one of the constituents is represented by a line. For example, the dot and dash line represents 24 per cent water, which, as has been stated before, must not be crossed if nitrations in iron equipment are to be made. The percentages of any two constituents fix the third and locate a point, A' , for instance, being 5 per cent water, 75 per cent sulphuric and 20 per cent nitric acid. The dotted fine lines are the loci of molecular substitution of nitric acid by water and represent the sulphuric-water concentration throughout the mixed acid medium.

In nitrating benzene by adding the hydrocarbon to the mixed acid, no DNB will be formed providing the average temperature does not exceed 30 deg. C. and the mixed acid used lies in the chart area within the lines 20 per cent water, 1 per cent nitric acid, the nitration line through 20 nitric and 60 sulphuric and the dot and dash line.

This process suffers from the disadvantage that the proportion of waste acid to nitro compound is large, due to the comparatively low initial concentration of the nitrating acid. Present practice is to use an acid of higher concentration to reduce the amount of waste acid and increase the capacity of the nitrators. To prevent DNB from being formed the nitrating acid is run into the benzene, an excess of which always is present until the acid concentration reaches a point low enough to prevent di-nitration. The introduction of the Hough nitrator described at the end of this article made it necessary to modify this process because the bulk of heaviest material at the beginning of the nitration must be sufficiently large to cover the port-holes of the nitrator, which is required to obtain positive circulation of the liquid. To allow the use of highly concentrated acid a sufficient amount of waste acid is introduced to increase the initial volume as required. Hereby the efficiency of agitation is main-

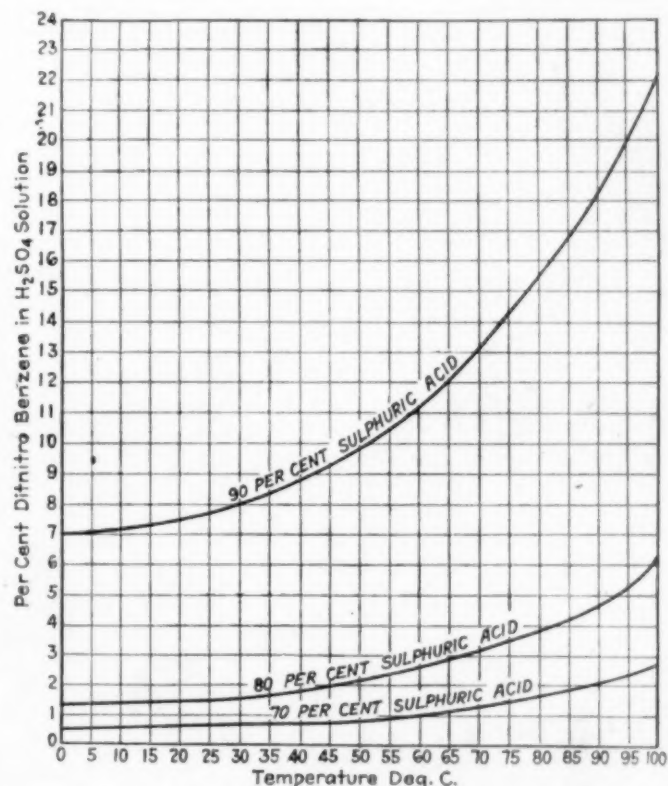


FIG. 3. SOLUBILITY OF DNB IN SULPHURIC ACID

tained and the actual acid concentration of the acid is lowered to a point at which there is no danger of forming DNB. In order not to reduce the capacity of the nitrator, part of the charge is withdrawn in proportion to the amount of acid charged and this part, known as cycle acid, is used in the next charge for the increase of the initial volume.

Dinitrobenzene can be formed direct from benzene at higher temperatures and mixed acid concentrations. A' mixed acid gives the highest yield of meta, the product having a melting point of 83 deg. C. A'' mixed acid gives a product setting at 79 deg. and A''', 75 deg. C. The temperature must be held to about 30 deg. while the benzene is being charged and then be allowed to rise gradually to 100 deg. during the time required for the completion of the reaction. The spent acid from A' will be B', which is located below the perfect nitration line, due to the reduction of a small part of the nitric acid and the formation of nitrosyl sulphuric acid. The only method known for recovering B' spent acid is to dilute to C' practically all the nitrosyl sulphuric acid being decomposed and 7 of the 8 per cent of DNB dissolved in the acid being liberated by the operation. After denitration, in concentrating the diluted spent acid to 96 per cent, the last traces of organic matter are removed.

Mixed acid A''' is especially suited for the production of NCIB and A'', DNCIB. The diluting operation fol-

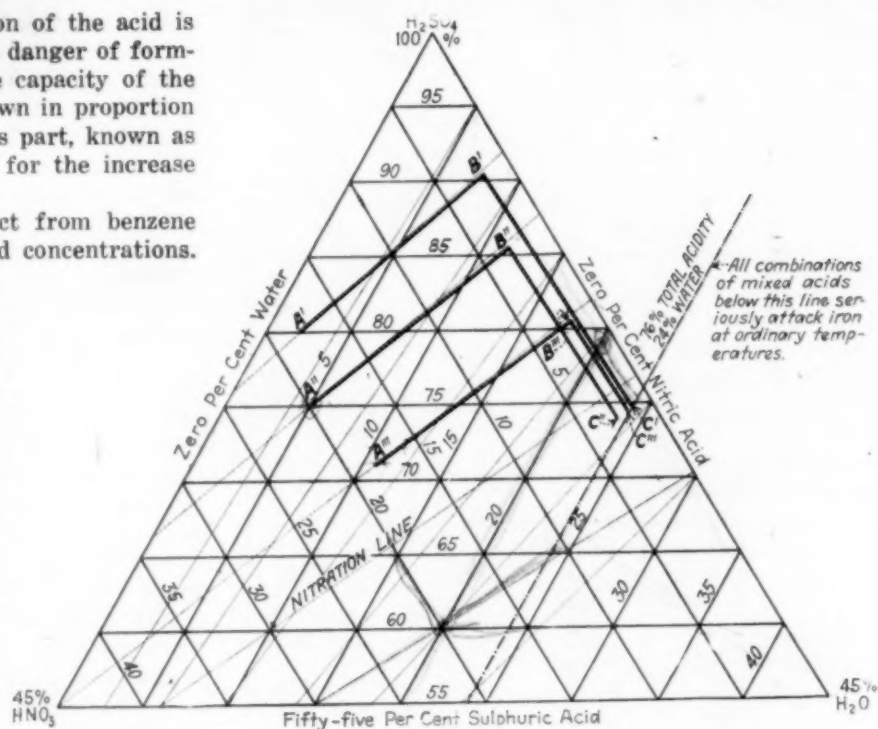


FIG. 4. MIXED ACID SYSTEM

lowing that of nitration is shown graphically on the chart. Every plant where nitrations are made should be supplied with a laboratory nitrator, in which test runs are made to determine the best mixed acids and temperatures to use to get the most desirable product and yield.

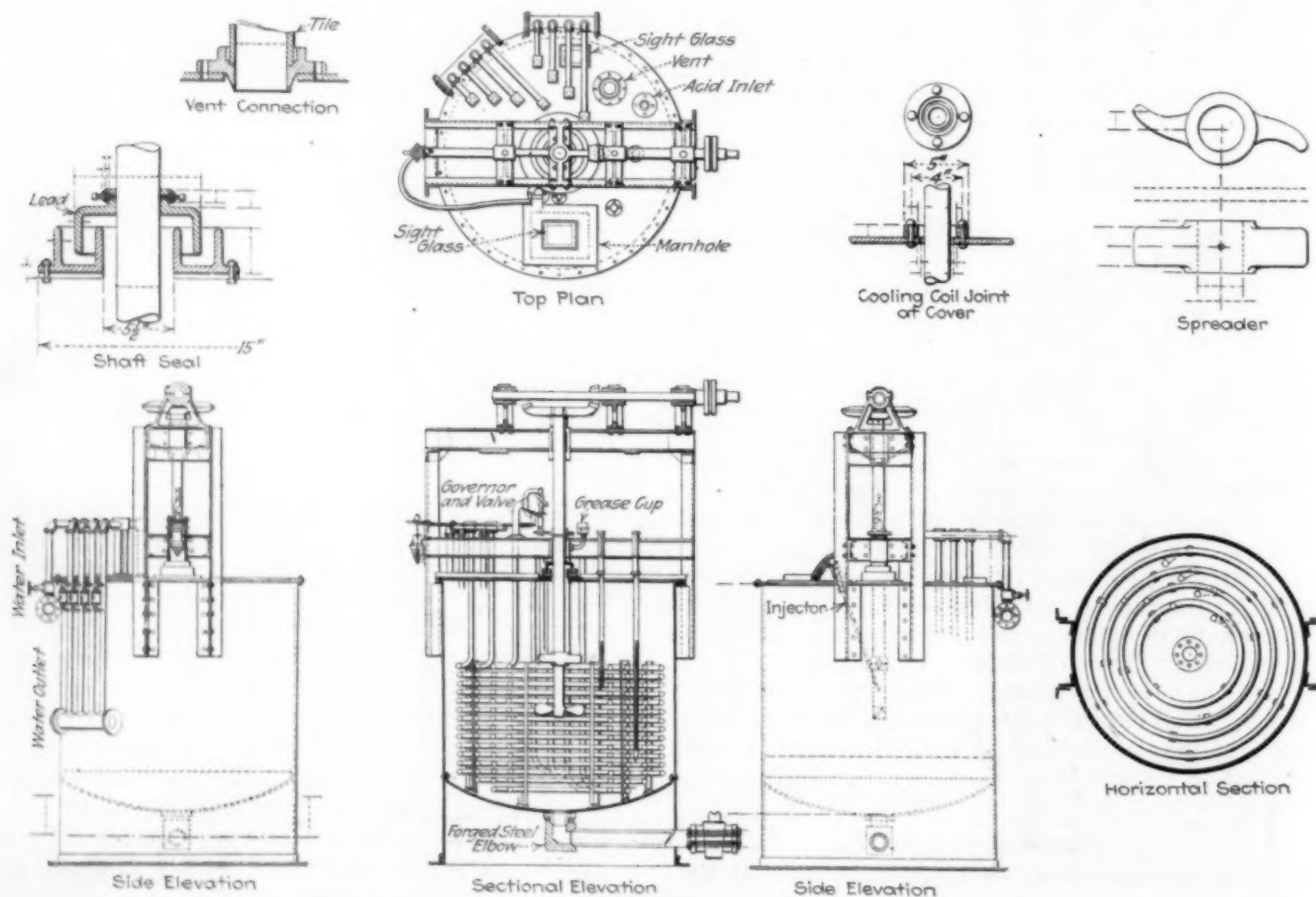
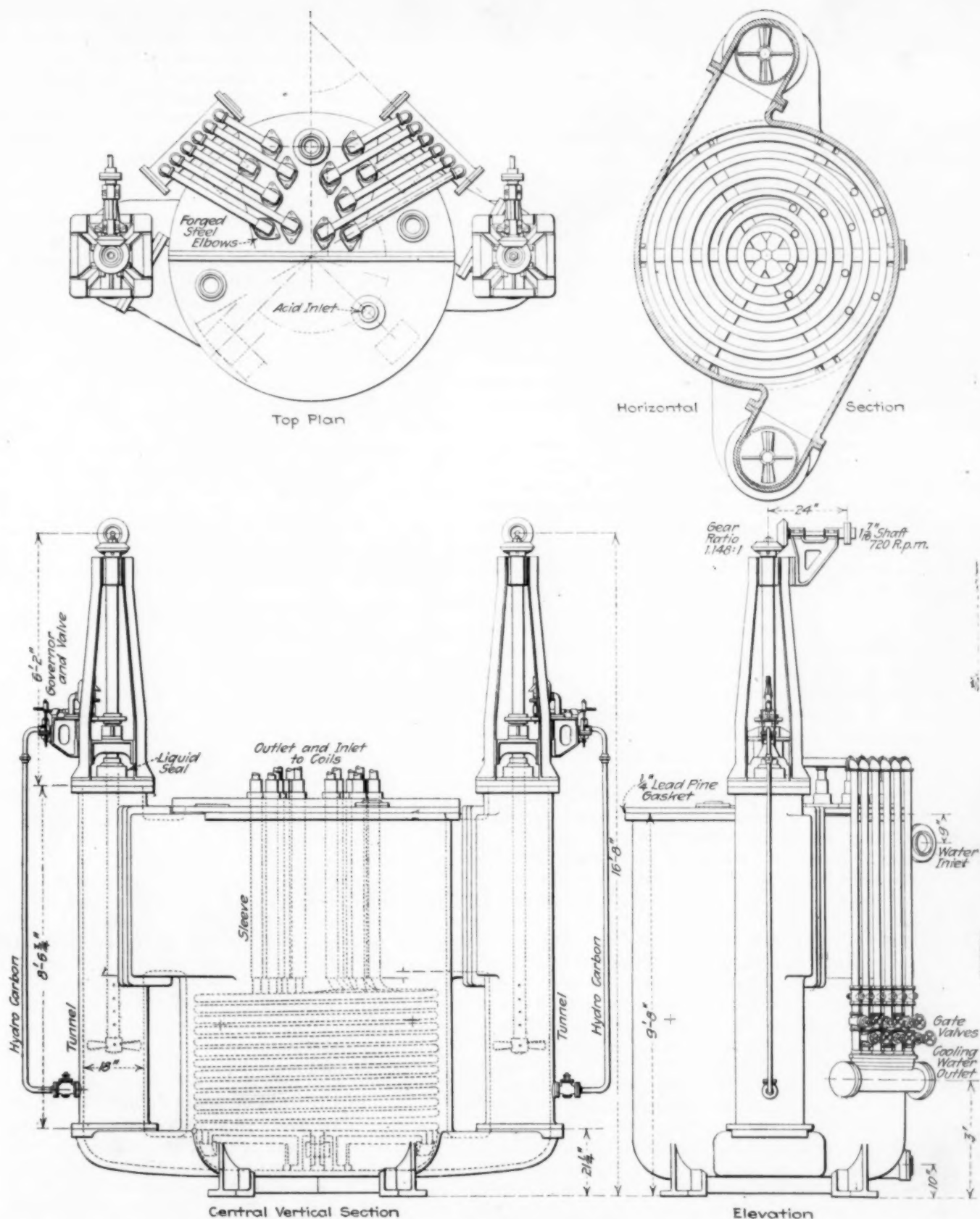


FIG. 5. HOUGH NITRATOR, FABRICATED STEEL, COIL TUNNEL



THERMO-REACTION

The heat developed per kilogram of benzene by mono nitration is 458 kilogram calories, which is sufficient to raise 1 kg. of mixed acid 1,000 deg. C., taking 0.458 as the average specific heat of mixed acid. If the reaction were instantaneous, the points of nitration would

be raised over 250 deg. C. in the case of mixed acid A', where the ratio of reagents would be 4 mixed acid to 1 benzene at the point of contact. However, the reaction actually takes place slowly enough that with suitable agitation and rate of feeding its heat can be dispersed through ratios up to 1,000 mixed acid to

1 benzene and the temperature rise decreased to a maximum of 5 deg. and an average of less than $\frac{1}{2}$ deg. per lb. benzene added. If this heat should not be distributed, the di-nitration would start up, shooting the temperature up to about 200 deg. C., where sulphuric acid would present an active phase, giving rise to a violent and very dangerous reaction of a sulpho-nitro-pyrolytic nature.

COMMERCIAL NITRATIONS

The first nitrations made on a commercial scale were started in 1856 by Simpson, Maule and Nicholson, in England. Twenty 1-gal. bottles set in pails of water were their nitrators. A quart of benzene was placed in each, then the operator added a few ounces of mixed acid, shook well, put the bottle back into its bucket to cool and proceeded in the same manner until by the end of the day he had added 6 lb. of mixed acid to the quart of benzene in each bottle. By this method one operator could produce about 6 gal. of nitrobenzene per 12-hr. shift.

Engineering chemists, and we use this term purposely to make a distinction between the terms chemical engineer and engineering chemist, eventually improved this laboratory prototype by making it larger, of cast iron and with cooling jacket attached. These nitrators grew in gallon capacity very rapidly, but the fact seemed to be overlooked that the heat exchange area increased as the square and the volume as the cube of the expanded unit; thus, other things being equal, only about 60 per cent actual production increase would be obtained every time the volume was doubled; this resulted in large numbers of medium-sized machines being used, often as many as twenty together, after the manner of the bottle nitrators just mentioned. Thus if the volume is increased from 400 to 800 gal. the production of the 800-gal. nitrator is only 1.6 times that of the 400-gal.; if it is increased from 400 to 1,600 gal., four times in volume, the production is increased only 2.5 times, and from 400 to 3,200 gal., the production increases about four times.

Internal cooling coils also were introduced but only of limited cooling capacity, while little or no improvement was made in the construction of the stirring devices.

The German dye-plant chemical engineers Neumann, ter Meer and Kubierschky each overcame the heat exchange and temperature control problem with special designed continuous nitrating machines having very great capacities but requiring exceptionally well-trained operators to keep them running satisfactorily.

During the recent war when TNT had to be made in quantities of thousands of tons, new types of nitrators were designed, built and operated, having a central tunnel. In nitrating capacity, they proved superior to the best type of equipment that had ever been developed in Europe. Figs. 5 and 6 are drawings of the Hough types. Two things should be noted in the central vertical section of Fig. 6:

Six steel-coil heat interchanges, 1,400 ft. in pipe length and capable of passing 500 gal. of water per minute are installed in the body of the machine. They will easily absorb the heat nitration of 125 lb. of benzene per minute with a very low temperature head. The choice of this design was made because of the mechanical action of a coil heat interchanger in equalizing the cooling water temperature and maintaining

rapid heat flow through the walls of the pipe. The outlet and inlet pipes to the coils are protected by renewable sleeves which prevent condensed nitric acid vapors coming in direct contact with and cutting the steel pipe. The space between the pipe and sleeve is filled with water glass, gilsonite or other durable acid-proof packing. The cooling water is drawn through the coils and not forced through, so that if leaks should develop, the acid will be drawn in instead of water forced out into the nitrator.

The tunnels running vertically from the base to the upper half of the body of the machine form the reaction chambers. The hydrocarbon is forced through a spray nozzle into each tunnel at a point about 12 in. below the propeller, which moves a volume of about 5,000 gal. of mixed acid per minute. The mixing action of these propellers, having from 600 to 800 r.p.m. and confined within an 18-in. tunnel, is very efficient. Temperature control in the tunnel is obtained by the speed of mixing being more rapid than the reaction velocity, making it possible to diffuse the heat through a very large mass of mixed acid. Recording thermometers are so placed that the operators know the temperature at the tunnel exit and around the coils. The exits of the tunnels are set tangent as shown in the horizontal section so that discharged liquid maintains its momentum in a whirling motion, giving maximum velocity over the coils and keeping the contents well mixed.

The application of this nitrator is by no means limited to the manufacture of TNT. It can be used to great advantage in the production of any of the nitro hydrocarbons or halogen derivatives, in which a large excess of strong acid is used, making it possible to inject the hydrocarbon into the nitrating acid. As already explained for mono nitrations, the process is modified, the nitrating acid being run into the mixture of hydrocarbon and cycle acid.

A simpler form of construction, built of steel with the central coil acting as a tunnel for the agitator, can be used for the nitration of glycerine and the chlorination of benzene and also for the nitration of sulphonic acids, in which close temperature control is vital. By using the coils as heating coils other reactions like sulphonations and reductions, for instance of dinitrobenzene to metanitriline, can be conducted in this apparatus. In fact, it can be regarded as a machine which will have its place in the large-scale manufacture of those products in which the close control of temperature is of primary importance and of those in which immiscible liquids have to be brought in contact in a finely divided state.

Critical Constants Tables

Dr. Charles H. Herty made an appeal to the audience for support of the work of the National Research Council in getting contributions to finance the tables on critical constants. An enormous saving will be made by this co-operative work and all companies will reap the benefit at a very moderate expense, which should not be borne by a few but by all. It is up to each and every technical man to advise the executive officials of his concern that this is an important investment for them to make, not a contribution to charity, a book subscription or a gamble but the purchase of tools for the technical department that are greatly needed.

At various times this journal has made editorial

appeals to its readers on this subject. However, if more definite details are desired than we have been able to publish, we would advise every one thinking of subscribing to the fund to write to Hugh K. Moore at Berlin, N. H., who has been freely giving his time to getting funds together. Many small voluntary subscriptions are wanted as well as large ones.

Recoverance

BY ROBERT G. GUTHRIE

EXTENSIVE research on recoverance has been carried on with a view to relating the recoverance values of various materials with the fatigue, wear and durability values of said materials in such a way that the adaptability and quality of any material for any specific purpose may be arrived at in simple, understandable terms and by simple, quick tests. In order that you may know what I mean by recoverance I will give you the general definition as established by S. W. Widney and also the explanation of it.

Recoverance is the capacity of a material to return immediately the energy that has been imparted to it by any external forces.

In other words, when the molecules of a material are forced by compression, tension or bending from their relative normal position the force *immediately* exerted by these molecules after the disturbing force is removed, in their return toward such normal position, is the recoverance of the material.

RECOVERANCE PERCENTAGE

The recoverance figures as they are given in all of these tests represent a percentage, depending upon the areas beneath the increment of loading curve and decrement of unloading curve. I speak of the rate of recoverance as regards fatigue, and these figures are in reality manifestations of the rate of recoverance. An explanation of this will qualify the use of the word "rate." Not knowing of any mechanism available capable of recording a recoverance curve or the rate of recoverance following the instantaneous removal of the total load necessitates the plotting of a recoverance curve under a series of loads. These curves, however, will be the same in either instance, whether they are the result of the application of one load and its removal, or this same amount of load applied in several increments and removed in successive decrements.

In a curve plotted automatically covering the action of the material under a cycle of stress or repetitions of such cycles, the unloading line will diverge from the loading line in exactly the same way as one plotted under load. But in plotting the curves under load the complete cycle of loading and unloading is stopped during its course at definite points represented by the weight of each increment, and the deflections are noted.

After this material has been loaded to any predetermined number of increments, and any of these increments removed, a point is reached which does not coincide with the corresponding point on the loading line. A loss then is represented by the divergence of the unloading from the loading line, and as long as this particular load remains upon the material this distance will represent a total loss in strength to the material. If, however, the total load is removed at one time, similar to the removal of the load during repetitions of stress, this curve will not stop at any of these points

but will pass through them on its course back to the origin, zero. It then follows that whatever the recoverance figure be the rate of recoverance will be directly proportional—i.e., if the curve of a material is plotted under load and a definite recoverance noted such as 90 per cent, and another graph plotted covering a different material showing a recoverance figure of 40 per cent, it will then follow that the material showing the recoverance value of 40 per cent is lower by 50 per cent in recoverance and also lower by 50 per cent in the rate of recoverance.

It then follows that the lower the percentage of recoverance the lower is the rate of recoverance, and the higher the percentage of recoverance the higher the rate.

FATIGUE FACTORS

There are in use three ways of measuring recoverance: by bending, by tension and by compression.

The relation of recoverance to hysteresis will now be seen, and using a basis of 100 per cent we will then have 100 per cent minus the recoverance equals the hysteresis, or 100 per cent minus the hysteresis will equal the recoverance. As regards metals, I do not say that recoverance alone is a conclusive measure of a material's susceptibility to fatigue, but the recoverance of a material is a direct indicator of the material's ability to withstand fatigue. After a great number of tests on metal bars of various composition, the following theories are set forth as regards the relation of recoverance to fatigue.

The definition of fatigue, as given in Merriman's "Mechanics of Materials," is "the loss of molecular strength under stress often repeated," and I am speaking particularly of stress within the so-called elastic limit.

The direct factors governing fatigue are the manner, frequency and magnitude of stresses. It follows then that any material will fatigue and ultimately fail when the rate of repetitions of stress of any magnitude, within the elastic limit, is greater than the rate of recoverance, and conversely, there will be no fatigue when the rate of repetitions of stress of any magnitude, within the elastic limit, is less than the rate of recoverance. There is, however, a recoverance beyond the elastic limit—i.e., beyond what we now call elastic limit—and this promises to be a very important and interesting field of investigation, although to date we have not done a great deal on this.

I am speaking at present of metals, which are a crystalline substance, and obviously the recoverance beyond the elastic limit of such a substance is a great deal less where the elastic limit is nearer the ultimate than it is in a material where the elastic limit and the ultimate are farther apart. A material such as boxboard might show an ordinary amount of recoverance within its elastic limit, and between the elastic limit and the ultimate will show a proportionately greater amount than does a steel, whereas the steel will show a proportionately greater recoverance within the elastic limit than does the boxboard—i.e., I do not mean that boxboard may be compared to steel, but that the boxboard will show proportionately greater recoverance between its elastic limit and its ultimate than the steel would between its elastic limit and its ultimate, as compared to the recoverance below the elastic limit of the steel; and in an amorphous material such as fused silica, it would be obvious that all the recoverance it

would have been below the elastic limit, because the elastic limit and ultimate are so close together that we probably would never be able to measure any recoverance between the two. What I have just said seems to be characteristic of these three different characters of structure in any material, and evidently then the recoverance is governed not only by homogeneity of structure but by density and fineness of structure as well.

CREEP

There is also a phenomenon exhibited by different materials that is theoretically common to all, but is more practically apparent in such materials as paper, textiles, felts, rubber, etc., and that is that there is not only the recoverance, which is, as you will remember, the immediate comeback of the material, but there is after the recoverance a noticeable creep, which in some instances reduces the original hysteresis area as much as 50 per cent. In plotting curves covering tests of a material of this nature we have in reality three areas beneath the increment or loading curve; namely, the recoverance area or immediate comeback; the creep area, the extent of which is dependent upon a time factor and the degree of accuracy of the instrument used; and the hysteresis area, a part at least of which is a definite loss of the energy applied, which results in a loss of molecular strength. However, there evidently is a part of this hysteresis area which may belong more accurately to the creep area and should be so characterized. Therefore, the true lines of demarkation between these areas and the extent of the areas themselves are dependent upon the accuracy of the methods used to determine them. However, this does not alter the fact that they exist in material and definite knowledge regarding them should prove of great value in determining the adaptability of any material for a given purpose.

I have been speaking of the elastic limit of various materials and although I recognize the present means of determining the elastic limit I also believe that we will eventually arrive at a better understanding of what the term elastic limit really means, and its relation to hysteresis. I personally believe that the hysteresis is proof that the elastic limit is zero, according to the following:

Hysteresis, the accumulative result of having passed an infinitesimal number of elastic limits of infinitesimal magnitude, and there probably exists in matter as many elastic limits as there are subdivisions of matter, and the elastic limit of the smallest subdivision is zero.

What actually happens when a bar of metal is stressed is that *first* the slightest load will theoretically cause, to some degree, strain. It may be too fine to measure, but it nevertheless exists, and inasmuch as the smallest subdivision has a zero elastic limit and each subdivision above the smallest is the result of a combination of these unit subdivisions, it then follows that hysteresis begins to develop as soon as any stress is applied, and as soon as the smallest amount of hysteresis capable of existence is developed it is evident that the elastic limit of the smallest subdivision of which matter is capable has been passed, and that indicates that the elastic limit of any matter is proportional to the degree of subdivision of which matter is capable, and if smallest subdivision of matter equals 1, the elastic limit will also equal 1, and the result of the limit of elasticity, which is hysteresis, is also equal to 1.

Inasmuch as all matter possesses the property of recoverance in some degree you can readily see the

value of being able to determine and understand it, and after this is accomplished it will no doubt open up a great many avenues of explanation regarding the peculiar properties various materials exhibit.

In the work that I have done on this property and in all the tests that have been made in the Widney Laboratories there is one outstanding feature, and that is that the recoverance of a material reflects that material's quality.

We now have definite units of measurement of time, weight, distance, etc., and ultimately and probably before long definite values will be universally established whereby the quality and durability of any material will be measured in units of recoverance.

Canada and the Chemists

BY C. PRICE-GREEN

THE visit of the American Institute of Chemical Engineers to Canada last summer was a very notable event and marked an epoch in the history of the industrial development of our country. It was a tribute to the fact that Canadian chemical industries had advanced to a point where they were worthy of attracting the attention of perhaps the most important body of technologists on this continent, with the result that the people of Canada realized that things had been going on in their midst of which they had little or no knowledge; further, the engineers and chemists of Canada fully appreciated the importance of this visit, because it brought men of common interests together and laid the foundation of co-operation and consultation on the problems of the two countries.

WORK FOR THE CHEMICAL ENGINEER

Chemistry is the foundation of the modern industrial structure and the chemist is the keystone, but there is no doubt that in the past this branch of science has not met with the recognition it should, and perhaps the chemist cannot be altogether absolved from blame, as he has consistently hidden his light under a bushel, instead of endeavoring to convey to the lay world the tremendous significance and great value of his work and the debt the industrial world owes to the basic principles of chemistry and science. There is little doubt that the achievements of the enemy were, in many cases, much overrated, but one thing he did which must be recognized as a lesson to us, and that was to supply the missing link between the academic chemist and the industrial investor.

The chemical engineer covers a wide field, and in choosing my subject I considered that a review of the resources of Canada would be pertinent, because of the rich stores of raw material contained in this country that are of interest to the chemist engaged in dealing with forest products, metals and economic minerals, agriculture and fisheries.

This generation has been a miner of natural resources; the plethora of wealth on this continent has been such that economy in the utilization of its resources has been conspicuous by its absence, but the day is coming—nay, is here—when many of these resources show depletion and the necessity of conserving them becomes evident; the value of byproducts, wasted in the past, is now being realized, and that is where the service of the chemical engineer comes into its own.

During the war the chemical industries of Canada

made phenomenal strides, and it can be said without exaggeration that development followed development in a most sensational manner; unhappily, on account of the very nature of much of this work, very little could be said about it at the time, more particularly about those industries engaged in connection with our war effort. You have been to Shawinigan Falls and Niagara Falls and are familiar with what was going on at other places, and I feel that I can add nothing to your knowledge of those developments.

During the period of the war, it is worthy of note, the exports of chemicals from Canada increased about 800 per cent and the number of firms engaged in chemical industry has risen to the respectable figure of over five hundred at the present time.

CANADIAN NATIONAL RAILWAYS

One cannot speak upon the resources of Canada without reference to that important medium which has made these resources available to the commercial world. I allude to our national railway systems. The government-owned line, the Canadian National Railways, has grown remarkably in recent years and now has over 22,000 miles of line, the largest system under one management, and is operating freight steamers for the extension of Canadian commerce all over the world. Some of the units of the national system, notably its western lines, formerly known as the Canadian Northern, have been the means of opening vast areas of rich agricultural country in the northern parts of the prairie provinces and filling them with people, which has created a most important market for the manufacturer of the eastern provinces and has perhaps contributed more to Canada's progress than any other factor.

These western provinces have earned the name of the "bread-basket of the world." Only one-tenth of the surveyed area suitable for agriculture is settled at the present time, and in the not far distant future it will be producing over a thousand million bushels of wheat. When these lines were commenced in 1896 Canada exported less than 10,000,000 bushels of wheat; last year her agricultural exports exceeded \$600,000,000, of which grain was the chief element. It is a notable and interesting fact that this western country has been the only one so far found good enough for citizens of the United States to migrate to, and they are going there in thousands.

FOREST PRODUCTS

The vast latent resources of Canada and the great field it affords for enterprise can be dealt with only very briefly in the time permitted. As they are much in the public eye at present, I will first direct your attention to our forests. Today the United States is mainly dependent upon Canada for its supply of paper and paper-making material, and the demand is a heavy one, as you use one-half the world's annual production of white paper. Canada is supplying 55 per cent of this demand, which amounts to the equivalent of five and one-half million cords of pulp wood a year, which made into a pile of 4-ft. wood 4 ft. high would stretch 9,000 miles, or more than twice across the continent.

It may be of interest to you to know how Canada's pulp and paper industry has grown to a point where it can meet this demand. In 1890 it exported only to the extent of \$120; today there is \$250,000,000 invested in pulp and paper, and our annual production is valued at

\$120,000,000 and our exports \$100,000,000, of which you receive 80 per cent, and in addition to this over a million cords of wood to supply your mills. This is bordering on a controversial subject. Some people think that we are not supplying as much as we should, but in lumber parlance we think we are going the limit.

FOREST RESERVES

The pulp forests of Canada are tributary to the lines of the Canadian National Railways, and it is estimated that in Ontario and Quebec alone we have about 400,000,000 cords, not counting the wooded areas in the vicinity of Hudson Bay. This is sufficient to supply the present demand for seventy years. In British Columbia there is sufficient pulp wood to last the present output of Canada for sixty-five years.

Reforestation is being carried on to a greater extent every year, more particularly by private interests in the Province of Quebec, but the government is fully alive to the necessities of the case and a progressive policy will no doubt be adopted in the immediate future. Putting the length of time it takes to grow a spruce tree to commercial size at one hundred years, if a sane policy of cutting and forest preservation is followed Canada could carry on in perpetuity in spite of what the pessimist may say to the contrary. Mark well, however, my proviso, for the forest has many enemies; fire, fungus, the bud worm and wind all take a heavy toll, and it is very doubtful if we can count at all upon annual growth in our estimate of the life of our lumber supply.

Canada has the largest forest area within the British Empire, and British Columbia contains the most valuable standing timber in the country, amounting in all to about 366 billion feet of saw material. The major portion of this is tributary to the Canadian National Railways either by rail or water route. The principal commercial tree of this forest is Douglas fir, which attains a size exceeded only by the great trees of California. This forest supplies wood suitable for general construction purposes, which is in the greatest demand in the world's markets, and it may be of interest to many to know that from the silver spruce of those forests material for over 35,000 airplanes was produced during the war.

Canadian forests are, however, of little commercial interest to the United States, for while they will last Canada at the present rate of consumption for almost an indefinite period, providing they are properly looked after, if they were devoted solely to the supply of your needs they would not last the United States twenty years.

FOREST CONSUMPTION

I might mention that while industrial Europe consumes about 150 ft. b.m. per capita, the United States uses 350 ft., and for all purposes, including lumber, firewood, ties, etc., the United States consumes over 100 billion feet a year.

In order to visualize this stupendous figure, the best illustration I can give is that it would make a pile of solid sawn wood 4 ft. high by 4 ft. wide stretching 98,000 miles, or four times around the world; or, translated into terms of cordwood, it would measure ten times around the world. There is no doubt that unless the recommendations of your forest authorities are followed your resources will be exhausted in fifty years; in fact, you are facing a famine now. Some evidence of this is given in a pamphlet which is being distributed

to your members entitled "America's Forest Resources," in effect a plea for the conservation of the forests of the United States and Canada.

Water powers are so closely related to the manufacture of forest products that I might mention that Canada has developed nearly two and a half million horsepower or the equivalent of 275 hp. per 1,000 population, which means about 3 hp. for every person engaged in manual labor, not including agricultural pursuits. With the possible exception of Norway, this is the greatest per capita development in the world.

MINERAL RESOURCES

Mr. Price-Green then went on to describe the mineral resources of Canada. He told of the coals of Nova Scotia, which in conjunction with iron from Newfoundland and the mobilization of other commercial forces would result in one of the largest productions of iron and steel in the world, of the oil shales of New Brunswick and economic minerals of central Ontario, which embraces the largest number of minerals within a given area on the continent. He spoke of the great Laurentian Plateau, of which little more is known than its geological structure; about where the pioneer railways had opened up wonderful finds, such as the great mineral fields at Sudbury, which supply 80 per cent of the world's nickel, the silver mines of Cobalt, which have yielded so far over \$200,000,000; Gowganda and Montreal Rivers; the Porcupine gold fields, which are acknowledged today to contain the world's greatest gold mine, having produced so far \$50,000,000; Kirkland Lake, Larder Lake and Shiningtree, which also give great promise; the wonderful great copper find west of Lake Winnipeg. He told his hearers that Quebec produced 85 per cent of the world's asbestos; of the coal fields in Alberta, the greatest in the British Empire; of the wonders of the Mackenzie Basin, and the great Cordillian Range in British Columbia, 1,300 miles long by 400 miles wide, known to contain much valuable mineral, but so far only scratched.

CANADA'S FISHERIES

Canada's fisheries, described as "the greatest in the world," were also included in his remarks, with 7,000 miles of shore line on the Pacific coast and 5,000 miles on the Atlantic, the latter practically inexhaustible and having the advantage that the banks are only from ten to fifteen miles from shore. These fisheries could produce ten times as much as at present without showing signs of depletion and presented not only a splendid opportunity for investment of American capital but one for the chemist in the utilization of the enormous waste which could be made to bring a large return.

INDEFINITE KNOWLEDGE OF CANADA BY RESIDENTS OF THE UNITED STATES

Mr. Price-Green concluded by saying that many persons in the United States have a very indefinite knowledge of Canada and consider it in the light of Kipling's "Lad of the Snows," that has done more to damn its climate than anything ever said or written about it. They think of it as up near the North Pole, a country of Indians and dog trains; but he pointed out that Port Arthur and Fort William, at the head of the Great Lakes, were on the same parallel of latitude as Paris and Winnipeg, only one degree north of Paris, Edmondton the same as Liverpool and Calgary the same as London.

Ontario covers fifteen degrees of latitude, stretching a distance corresponding to that from Rome, Italy, to the north of Scotland.

Operating Data of a Modern Coke-Oven Plant

BY C. R. BELLAMY

THE Ford byproduct coke plant of Semet-Solvay ovens at River Rouge, Mich., was described by Mr. Bellamy. In our issue of Aug. 25, vol. 23, No. 8, pp. 321-328, we have published the original manuscript as prepared for the Canadian meeting of the Institute, but which was read by title only then due to insufficient time being allowed for the paper program. Many new graphical data were added and discussed.

It was shown that in the operation there has been no connection between the speed of operation and sulphate yield and it is worth while therefore to note what temperature changes have accompanied the change in operation speed. This can best be studied from amount of heat required. From March 1 to Aug. 1, on slow operation, it required about 2.3 millions B.t.u. to carbonize a ton of coal, while in August, on fast operation, 2.36 millions B.t.u. was used. This means that in August more B.t.u.'s were consumed in the oven flues in nineteen hours than were previously used in twenty-four hours. To be exact, slow operation required 1.61 million B.t.u.'s per oven per hour, while high-speed operation required 1.96 million.

The operating speeds are to each other as 80 : 100 while the B.t.u. requirements bear almost identically the same ratio—namely, 82 : 100. The temperature conditions may therefore be said to be directly proportional to the speed of operation.

EFFECT OF TEMPERATURE UPON AMMONIA YIELD

Here I wish to advance an opinion in regard to effect of temperature upon the ammonia yield. It is that the heat necessary for producing high-grade metallurgical coke, on short coking time, is not of itself disastrous to byproduct yields. If the heat is properly distributed, the carbonization chamber completely filled with coal and kept under a pressure of minimum variation, so that the gases evolved pass out quickly and always at the same rate, I believe that high byproduct yield can be obtained from the highest operation speeds. The essential factors for both coke and byproducts are:

1. A tight oven.
2. A full oven.
3. A proper distribution of heat in flues.
4. A back pressure on ovens and main, with minimum variation, 1 or 2 mm. kerosene oil.
5. A schedule for pushing, that is followed seven days a week.

The Utilization of Peat

B. F. Haanel presented an able address on the utilization of peat which was amply illustrated by means of moving pictures showing methods of operating on bogs. The beds were faced and fairly wide strips cut off by a specially designed machine. This operation was very efficient from a mechanical viewpoint. The chunks of peat were then loaded by hand into dump cars and carried to the plant, which was but a short distance away. Considering the large proportion of water in peat, it is evident that the handling operations must be very economically performed.

Ceramic Day at the Sixth National Exposition of Chemical Industries

Meeting of the American Ceramic Society—President Minton's Address on the Potter's Art and the Chemist's Science—Discourse on Decorative Architecture; Art in Ceramics—Classification of Sheet Steel Enamels

THE American Ceramic Society had its headquarters at Booth 750 at the Sixth National Exposition of Chemical Industries, Grand Central Palace, New York City, where the members registered and made arrangements for Ceramic Day, Friday, Sept. 24. The members met for luncheon in the ballroom of the Hotel Commodore at 12:30 p.m., about seventy-five members and guests attending. The afternoon meeting was opened at 2:30 by President Minton and Secretary Binns in the auditorium of the Grand Central Palace.

PRESIDENT MINTON'S ADDRESS

The president founded the text of this meeting in a paper on the potter's art and the chemist's science which is covered in part in the following paragraphs:

"The ceramic industry as we know it today with all its ramifications is the result of evolution from a primitive industry and may be likened to a great tree with many branches of which the stem and roots are the pottery industry. The art of potting extends back to prehistoric times and is probably the oldest of all modern industries. Three thousand years B. C., in the days of Egypt's great glory, the potter's art was a noble calling. According to legends of that time it was presided over by a great Egyptian god Num, who was the presiding spirit of the universe. Mythology would have us believe that it was this god who first worked in clays, and his greatest creation was man, formed of clay.

"In these ancient times the potter was a man of influence, ranking in some ways with the alchemists, and his art was wrapped in mystery. The pottery of this dim age was simple in form and adornment. The real history of these times has been preserved in clay forms while all other materials have perished. In fact, the history of the rise and fall of nations and the progress of civilization may, to a great extent, be traced from existing ceramic products. The Bible story of the creation of man from clay, and the brickmakers of Egyptian Bible times, lend the industry a romance possessed by no other."

THE POTTER'S ART

He further spoke of the development of Greek, Assyrian, Persian and Chinese pottery, showing the influence the potter had on the art of the time and the way the art has been eulogized in literature from Rubaiyat to Longfellow's poem "Keramos" and continued:

"Although pottery is one of the oldest, if not the oldest, of modern industries, it has been one of the last to voluntarily seek the aid of science in solving its problems. Unlike many other industries the processes involved are not strictly mechanical or chemical. Potting is part art as well as part science. A man may be a scientist and yet never be a potter, but a successful potter must use some principles based on science, whether he knows it or not. Again, the ceramist is

dealing with impure raw materials, which prevents strict dependence upon scientific or chemical methods alone.

"Up to within the last twenty years the whole industry has been so hedged about with so much secrecy and suspicion that modern scientific co-operation made little headway. That period is past. Many a manufacturer who has hedged his methods with secrecy and disdained to take advantage of technical knowledge has suddenly been rudely awakened to find that this competitor, who depended upon technical methods for progress, had outdistanced his closely guarded methods. The search for knowledge is free for all, and physical barriers cannot prevent its being discovered. In many of the operations in the ceramic industry chemical processes are involved, and most of the improvements, technically, have been the result of painstaking experiments by men grounded in science. One of the most notable was the production of hard porcelain in Europe from attempting to duplicate the Chinese porcelain. It was largely scientific work on the part of Dr. Seger which founded the great porcelain industry of Germany and Austria. It was mainly by scientific researches that Wedgwood was able to produce the beautiful pottery which makes his name famous.

FUTURE WORK FOR CHEMISTS

"In the various branches of this industry the ceramic chemist and the ceramic schools are unable to turn out trained men rapidly enough to meet the ever-increasing demand. For this the greatest credit is due to the American Ceramic Society. The war caused us to realize suddenly that our former slipshod methods of selfish inefficient individualism were no match, industrially, for the thoroughly organized teamwork of German industry. The future work of our chemists will be largely confined to research in discovering facts involving the fundamental principles underlying the processes of the industries, and it will be the work of our engineers to put this knowledge into practical operation."

After showing the relations of ceramics to all the other industries and engineering professions he concluded as follows:

"Is there anything not dependent upon the ceramic industry? When we consider the beauty of our pottery, the magnificence of our buildings, the usefulness of our glass products, the general importance of our industry as the keystone in the arch of all the industries and the awakening spirit of co-operation and advancement shown by our members, we can be proud of the ceramic industry and the American Ceramic Society."

DECORATIVE ARCHITECTURE

Leon D. Solon of the American Encaustic Tiling Co. delivered an interesting little discourse on decorative architecture. He said that when science is active, art lies dormant, but now in the American Ceramic Society

we have a development of both. Due to the clearer atmosphere in the United States a most recent progress has been made in the development of color and polychrome effects in architecture. Because of the ceramist's knowledge of colors which may be obtained through physical and ceramic chemistry the architect must look to the ceramist for new developments.

PLEA FOR LEADERSHIP IN CRAFTSMANSHIP

J. Munroe Hewlett, an architect of New York, delivered an address which contained a plea that every craft must take the leadership in training its own artistic producers. Just as a child may ask for bread and be given a stone, so the architect has been asking the terra cotta manufacturer for faience had been given a bad imitation of granite. The ceramist must find out what he ought to produce. Artists have not been trained as craftsmen and therefore do not know what can be produced. It is deplorable that art has ceased to be recognized as the final flowering of good craftsmanship. This is nevertheless true. In the case of the automobile it is the most artistic achievement of our modern day, but artists have had nothing to do with it. Likewise we are at the dawn of a renaissance in architecture.

In the discussion of this paper Secretary Binns confirmed the ideas of Mr. Hewlett, and Mr. Dressler said that no art can live on the past alone, and it is only from the craftsmen we can expect future development. The ceramist must, however, have time to develop the art and not be hurried on deliveries of materials.

Secretary Binns delivered a paper on the significance attached to the term ceramic in ancient and modern usage, which is an abstract from a report of the committee of the American Ceramic Society and has recently appeared in the journal of the society.

CLASSIFICATION OF SHEET STEEL ENAMELS

R. R. Danielson of the United States Bureau of Standards presented an able paper giving the most recent findings of the bureau on the classification of sheet steel enamels. He said in part:

"An inspection of commercial formulas for sheet steel enamels shows a considerable variation in the chemical composition in certain instances, even in the case of enamels used for the same type of wares. But in spite of these permissible variations a study of a large number of commercial formulas shows that there are certain typical groups into which these various compositions can be placed.

"Sheet steel enamels may be classified generally into two rather distinct groups—that is, the gray ware or so-called granite ware enamels and the three-coat enamels. In the first group we have a single coat of enamel applied to the metal and mottled by the formation of rust spots on the metal. This ware is given a single firing, when it is finished and ready for the trade."

Formulas were given for gray ware typical of some of the earlier types of enamel containing a comparatively high content of quartz in addition to feldspar as a refractory, or with the use of opacifying agents in the form of fluorspar potash and antimony oxide.

Other formulas were given to show the tendency to reduce the amount of quartz and replace it with feldspar and also to eliminate quartz and use feldspar as the sole refractory.

Three-coat enameled ware, as the name indicates, is coated with three coats, a ground and two cover enamels,

thus differing from the single-coat gray ware. Tables were shown with high content of quartz and low amounts of fluxes, with high sodium oxide enamel and a medium content of refractories and with high boric acid content for the manufacture of light-gage drawn and spun ware. Formulas were also given for the cover coat on three-coat ware. Other data were presented on color enamels, including blue, black, yellow and green. The author concluded:

"In this paper have been given compositions of typical enamels applied to sheet steel, together with reasons for their use. It has not been intended to cover the field of possible composition, but it has been the purpose of the writer to present proved compositions which yield the several kinds of commercial enamels and enable the makers of enamels to compare them with their own."

This paper will subsequently appear, with the formulas, in the *Journal* of the American Ceramic Society.

Homer F. Staley of the U. S. Bureau of Standards presented a paper on "Possibilities for Research and Development in the Field of Refractories," which will be printed in a subsequent issue of CHEMICAL & METALLURGICAL ENGINEERING.

Among the motion pictures on the evening program "The Manufacture of Electric Bulbs" and "The Manufacture of Pottery" were shown through the courtesy of the American Ceramic Society.

July Exports of Dyes and Dyestuffs

The Bureau of Foreign and Domestic Commerce reports for July:

DOMESTIC EXPORTS FROM THE UNITED STATES BY COUNTRIES

Countries	Aniline Dyes, Value	Logwood Extract, Value	All Other, Value
Belgium.....	\$33,668	\$3,675	\$1,500
Finland.....			1,316
France.....	34,516	61,542	82,695
Germany.....			1
Italy.....	73,242	87,412	41,473
Netherlands.....	320	26,260	10,183
Norway.....			2,175
Portugal.....	332		
Spain.....	60,157	21,845	10,096
Sweden.....	1,045		14,284
Switzerland.....	49,880	27,012	13,225
England.....	188,593	53,382	213,377
Scotland.....	2,560		21,636
Ireland.....			2,000
British Honduras.....			35
Canada.....	189,589	16,716	134,261
Costa Rica.....	53	141	545
Guatemala.....			64
Honduras.....			92
Nicaragua.....			123
Panama.....			192
Salvador.....	823	15	
Mexico.....	45,579	293	27,906
Newfoundland and Labrador.....	500		170
Jamaica.....			33
Other British West Indies.....			13
Cuba.....	3,165	227	1,169
Haiti.....			34
Dominican Republic.....			82
Argentina.....	58,957		446
Brazil.....	32,776		9,575
Chile.....	10,146	343	7,896
Colombia.....	1,799	180	9,072
Ecuador.....	3,191	389	
Peru.....	16,028	315	6,544
Uruguay.....	2,233		
Venezuela.....	5,774		368
China.....	537,160		192,960
British India.....	146,334		61,952
Straits Settlements.....	65		
Dutch East Indies.....	9,450		59
French East Indies.....	11,080		655
Hongkong.....	80,283		6,628
Japan.....	153,625		65,750
Australia.....	1,493		2,295
New Zealand.....	6,426		2,988
Philippine Islands.....	8,967	250	24
British South Africa.....	226		108
French Africa.....	150		442
Morocco.....	595		320
Egypt.....			649
Tota ¹	1,770,780	299,997	947,411

Physical Properties of Arc-Fused Steel

Tests Cut From Blocks of Arc-Fused Metal Gave Mechanical Properties Like an Inferior, Porous Casting, Notably Deficient in Ductility, and Determined Entirely by Unsoundness in the Structure—Carbon, Silicon and Other Elements Are Lost From the Welding Pencil During Deposition

By HENRY S. RAWDON, EDWARD C. GROESBECK AND LOUIS JORDAN*

OF THE two forms of electric welding in common industrial use, the arc-fusion method is of far more general application than is electrical resistance welding; arc-welding, as is evident from its nature, can be applied in a multitude of ways to as many different welding projects, while the second method, which depends upon the contact-resistance of the two parts which are to be joined together, finds its greatest applications in "repeat" welding.

ARC-WELDING IN GENERAL

Of the two, resistance welding is much more closely related to the familiar weld of the smith's forge in that the two surfaces to be joined are heated to the welding temperature, the electric current being the source of the necessary heat, and pressed into intimate contact while hot. The principle of arc-welding, however, is very different; the two parts are joined together by fusion, the fused metal being supplied from an outside source rather than from the parts which are to be welded. Often the addition of a very considerable amount of metal is necessary, which metal is supplied by the fusion which is carried out by means of the heat of the electric arc. A layer of considerable thickness often exists between the two parts of the article which was repaired.

There are two distinct systems of arc welding, the carbon-arc, or the Benardos, and the metal-arc, or Slavianoff.

The Benardos system (also referred to as the "Benardos-Olszewsky" and "Benardos-Howard") employs a carbon or graphite electrode at one terminal of the electrical circuit while the article to be welded is connected to the other or positive terminal. A metal or "filling" rod is also used in conjunction with the carbon or graphite electrode for supplying the metal, which is melted to the weld by the heat of the arc.

The Slavianoff system uses a metallic electrode in place of the carbon or graphite electrode, as in the Benardos system, and thus molten metal is supplied directly from the electrode to the work to be welded. The Kjillberg and quasi-arc processes are modifications of the Slavianoff system, in which metallic electrodes coated with refractory materials are used. The Seimund-Wenzel process is another modification, where a magnetic field is employed around the metallic electrode and thus the molten metal is directed along the lines of force from the electrode tip to the work to be welded.

Two bibliographies have been published on electric welding: "List of Works Relating to Electric Welding," compiled by W. B. Gamble of the New York Public Library and covering the years 1786-1912, and "Bibliography on Electric Welding, 1914-1918," com-

plied by W. F. Jacobs and published in the *General Electric Review*, vol. 21, pp. 652-8. References to date have been completed at the Bureau of Standards.

AIM OF THE INVESTIGATION

During the year 1918 at the request of and with the co-operation of the welding research sub-committee of the Emergency Fleet Corporation an extensive program was outlined by the Bureau of Standards for the study of arc-welding. Due to changed conditions, however, at the close of the year 1918, the original program was modified and shortened very considerably. In drawing up the modified program, it was decided to make the study of the characteristic properties of the fused-in metal the primary object of the investigation, the study of the merits of the different types of electrodes being a secondary one. Since the metal of any weld produced by the electric-arc fusion method is essentially a casting, as there is no refinement possible as in some of the other methods, it is apparent that the efficiency of the weld is dependent upon the properties of this arc-fused metal. Hence a knowledge of its properties is of fundamental importance in the study of electric-arc welds.

PRELIMINARY EXAMINATIONS¹ OF ELECTRIC-ARC WELDS¹

Numerous articles have appeared in the technical literature bearing on the subject of electric-arc welding. Most of these, however, are devoted to the technique and comparative merits of the method, manipulations, equipment, etc., rather than to the study of the characteristics of the metal of the weld itself. The information on this phase of the subject is rather meager.

A considerable number of examinations were made of welds prepared by means of the electric-arc process and representative of different conditions of welding.

Most of these were of a general miscellaneous nature and the results do not warrant including a description of the different specimens here. One series of particular interest, however, may well be referred to in detail. As part of this study the welding research sub-committee submitted to the Bureau of Standards a number of welds of ship-plate representative of English practice for examination, some of which were considered as very superior examples of welding as well as others of a decidedly inferior grade. In Tables I and II are given the results obtained by the mechanical tests made upon these specimens. The welding was done by skilled operators by means of special brands of electrodes (welding pencils), the trade names of which, however, have been omitted from the tables. The specimens were examined microscopically very carefully, in addition to

*Published by permission of the Director, Bureau of Standards.
*Physicist, physical chemist and associate chemist, respectively, Bureau of Standards.

¹These examinations, as well as the preparation of many of the specimens used later in the investigation, were made by B. Hurvitz, formerly assistant chemist of the Bureau of Standards.

TABLE I. MECHANICAL PROPERTIES OF TWELVE GOOD WELDS*

No.	Average Voltage	Average Amperage	Type of Weld†	Thickness of Plate In.	Ult. Str. Tension, Lb./Sq. In.	Elong., Per Cent	Fracture
1.	d.c. 60	120	Vertical	1	51,450	7 in 8 in.	In weld; fine crystalline, some holes
2.	d.c. 60	120	Vertical	1	53,200	11 in 8 in.	In weld; fine crystalline, some holes
3.	a.c. 75	110	Flat	1	57,430	12 in 8 in.	Outside weld, few holes
4.	a.c. 75	110	Flat	1	54,210	14 in 8 in.	Outside weld, few holes
5.	d.c. 110	70	Flat	1	60,610	5.5 in 6 in.	Outside weld, few holes
6.	d.c. 110	125	Flat	1	59,000	6 in 6 in.	In weld; crystalline, fine to coarse, few holes
7.	d.c. 110	150	Flat	1	52,570	6 in 6 in.	In weld; very fine crystalline, few holes
8.	d.c. 110	100	Overhead	1	59,470	4 in 6 in.	In weld; fine crystalline, many holes
9.	d.c. 110	120	Flat	1	55,460	6 in 6 in.	In weld; crystalline, fine to coarse, few holes
10.	d.c. 110	120	Vertical	1	49,030	3.7 in 6 in.	In weld; coarse crystalline, few holes
Cold Bend‡							
					Load at Yield (Lb.)	Load at Break (Lb.)	Angle of Bend, Deg.
11.	d.c. 110	70	Flat	1	850	1,010	105
12.	d.c. 110	150	Flat	1	13,530	17,450	20

* All the welds were made in steel plate of the thickness shown. Electrodes of the covered type were used, the welds were of 60 deg., V type, except the overhead welds in which a 90 deg. V was used.

† Refers to the position of the plates which were being welded together.

‡ The bend tests were made with the apex of V in tension with a 7-in. span over a pin of 2-in. radius except the 1-in. plate for which a pin of 1-in. radius was used.

TABLE II. MECHANICAL PROPERTIES OF TWELVE INFERIOR WELDS*

No.	Average Voltage	Average Amperage	Type of Weld*	Thickness of Plate, In.	Ult. Str. Tension, Lb./Sq. In.	Elong., Per Cent	Fracture
13.	d.c. 110	120	Flat	1	32,460	Nil	In weld; fine crystalline, many holes
14.	d.c. 95	105	Vertical	1	19,890	Nil	In weld; spongy metal, poor junction with metal of plate
15.	d.c. 95	105	Flat	1	31,700	Nil	In weld; spongy metal, poor junction with metal of plate
16.	d.c. 60	120	Flat	1	37,290	2 in 6 in.	In weld; very fine grained with many holes
17.	d.c. 60	110	Vertical	1	38,820	2 in 6 in.	In weld; coarse crystalline, many holes
18.	a.c. 75	110	Vertical	1	31,360	Nil	In weld; fine to coarse crystalline, many holes
19.	a.c. 75	110	Vertical	1	27,090	1.4 in 8 in.	In weld; coarse crystalline, many holes
20.	d.c. 110	120	Vertical	1	39,400	3.5 in 6 in.	In weld; very fine grained with crystalline areas; many holes
21.	d.c. 110	120	Flat	1	34,650	Nil	In weld; very fine grained, very many holes
22.	d.c. 110	120	Flat	1	35,120	Nil	In weld; very fine to coarse crystalline, many holes
Cold Bend Test*							
					Load at Yield	Load at Break	Angle of Bend, Deg.
23.	d.c. 95	105	Flat	1	4,930	4,930	Nil
24.	d.c. 95	105	Vertical	1	4,120	4,610	1

* See corresponding notes, Table I.

the mechanical tests made. The results are not included, however, as the structural features of the material did not differ from those to be discussed in a later article. The results of the mechanical tests given are of value in that they are indicative of the average mechanical properties which should be expected in electric-arc welds of satisfactory grade for the shape and size of those examined.

METHOD OF BUILDING SPECIMENS

The specimens required for the study of the mechanical properties of the arc-fused iron were prepared for the most part at the Bureau of Standards,² direct current being used in the operation. The apparatus used is shown diagrammatically in Fig. 1. By means of the adjustable water rheostat the current could be increased progressively from 110 to 300 amp. By the use of automatic recording instruments the voltage and current were measured and records were taken at intervals during the preparation of a specimen. The values of current given below in the tables are those which were desired and were aimed at. The average deviation from this value as recorded by the curves was approximately 5 amp. The value of the current at the instant "the arc was struck" was of course many times the normal working value used during the fusion.

Since the investigation was concerned primarily with the properties of the arc-fused metal, regular welds were not made. Instead the metal was deposited in a block large enough to permit a tension specimen (0.505 in. diameter, 2 in. gage length) to be machined out of it.

²Credit is due A. B. Engle, formerly laboratory assistant, for aid in the preparation of many of the specimens.

Although the opinion is held by some welders that the properties of the metal of an arc-weld are affected materially by the adjacent metal by reason of the interpenetration of the two, it was decided that the change of properties of the added metal induced by the fusion

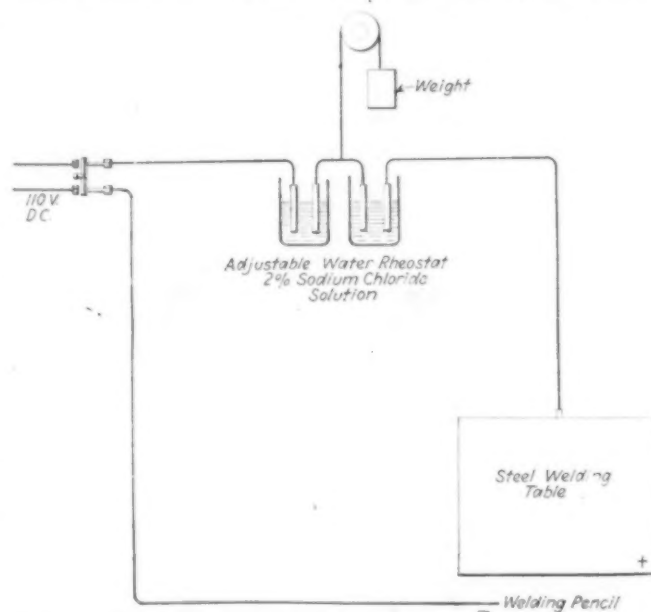


FIG. 1. ARRANGEMENT OF APPARATUS FOR WELDING

alone was of fundamental importance and should form the basis of any study of arc-welding. The method adopted also permitted the use of larger specimens with much less machining than would have been possible had the metal been deposited in the usual form of a weld.

In the first few specimens prepared (ten in number) the metal was deposited by a series of "beadings" inside a 1½-in. angle iron. The tension specimens cut from the deposited metal were found to be very inferior and entirely unsuitable for the study. This was largely on account of the excessive overheating which occurred as well as the fact that a relatively "long arc" was neces-

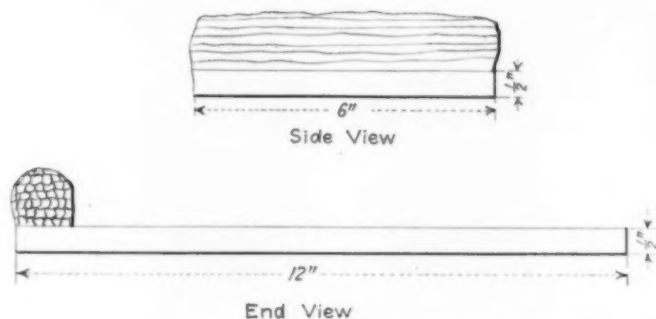


FIG. 2. METHOD OF FORMATION OF THE BLOCKS OF ARC-FUSED METAL

sary for the fusion in this form. Because of the very evident inferiority of these specimens, the results of the mechanical tests made are not given in the tables. The method of deposition of the metal was then changed to that shown in Fig. 2. This method also had the advantage in that the amount of necessary machining for shaping the specimens for test was materially reduced. The block of arc-fused metal was built up on the end of a section of ½-in. plate of mild steel (ship plate) as shown. When a block of sufficient size had been formed, it, together with the portion of the steel plate immediately beneath, was sawed off from the remainder of the steel plate. The tension specimen was turned entirely out of the arc-fused metal. No difficulty whatever was experienced in machining the specimens. Fig. 3 shows the general appearance of the block of fused metal as well as the tension specimen turned out of it.

In general in forming the blocks, the fused metal was deposited as a series of "beads" so arranged that they were parallel to the axis of the tension specimen which was cut later from the block. In two cases, for purposes of comparison, the metal was deposited in "beads" at right angles to the length of the specimen. In all the

specimens, after the deposition of each layer, the surface was very carefully and vigorously brushed with a stiff wire brush to remove the layer of oxide and slag which formed during the fusion. There was found to be but little need to use the chisel for removing this layer.

Two types of electrodes were used as material to be fused. These differed considerably in composition (Table III) and were chosen as representative of a "pure" iron and a low-carbon steel. The two types will be referred to as "A" and "B" respectively in the tables of results below. They were obtained in the following sizes: ¼, ⅜, ½ and ¾ in. ("A" electrode ⅜ in.). It was planned to use the different sizes with the following currents: ¼ in.—75, 110 and 145 amp.; ⅜ in.—145, 185 and 225 amp.; ½ in.—185, 225 and 260 amp.; ¾ in. (⅜ in.)—300 amp. The electrodes were used both in the bare condi-



FIG. 3. FORM OF SPECIMEN
Block of arc-fused metal with tension specimen cut from it. Approximately half natural size.

tion and after being slightly coated with an oxidizing and refractory mixture. For coating, a "paste" of the following composition was used: 15 g. graphite, 7.5 g. magnesium, 4 g. aluminum, 65 g. magnesium oxide, 60 g. calcium oxide. To this mixture was added 120 c.c. of sodium silicate (40 deg. Bé.) and 150 c.c. of water. The

TABLE III. COMPOSITION OF ELECTRODES BEFORE AND AFTER FUSION*

Electrode Type	Size, In.	Carbon		Silicon		Manganese		Phosphorus		Sulphur		Copper†		Nitrogen‡		
		Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	
A	$\frac{1}{4}$	0.058	{ 0.046 0.031‡	0.33	{ 0.007 0.007‡	0.042	{ tr tr	0.002	{ 0.005 0.005‡	0.057	{ 0.036 0.033‡	.....	.....	0.0030	{ 0.156 0.127 0.140‡
A	$\frac{3}{16}$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.0035	{ 0.140 0.123 0.124 0.113‡
A	$\frac{1}{8}$	0.022	{ 0.010 0.010‡ 0.033	0.16	{ 0.012 0.014‡ 0.006	0.038	{ tr tr‡ 0.069	0.002	{ 0.003 0.002‡ 0.012	0.040	{ 0.033 0.035‡ 0.043	.....	.....	0.0040	{ 0.126 0.131‡ 0.133 0.134‡ 0.117 0.111‡ 0.152 0.141‡ 0.132 0.135‡
A	$\frac{3}{8}$	.....	0.050	.....	0.11	.....	0.014	.....	0.011	.....	0.026	.....	0.063	0.0037	0.131‡
B	$\frac{1}{4}$	0.15	{ 0.027 0.024‡	0.06	{ 0.008 0.010‡	0.47	{ tr tr‡	0.018	{ 0.002 0.002‡ 0.004‡	0.021	{ 0.035 0.035‡	.....	.....	0.0032	{ 0.152 0.132
B	$\frac{3}{16}$	0.15	.....	0.001	.....	0.46	.....	0.014	.....	0.017	.....	.....	.....	0.0035	{ 0.124 0.121 0.122‡ 0.132‡ 0.117 0.123‡ 0.106‡ 0.108‡ 0.094‡
B	$\frac{1}{8}$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	{ 0.0022 0.0025	{ 0.119 0.111 0.112 0.108‡ 0.094‡
B	$\frac{3}{8}$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	{ 0.0014 0.0022	{ 0.133 0.098
C	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* The electrodes which furnished the specimens used for analysis after fusion were not the identical ones used before fusion but were the same stock.

† Determinations for copper were not carried out upon the unfused electrodes.

‡ Results were obtained from the fusion of coated electrodes.

§ Each of the results reported in the "after" fusion columns is the average of two determinations, excepting as noted below, made on one separate specimen.

Credit is due to J. R. Cain, chemist, Bureau of Standards, for this method, details to be published later.

¶ Average of nine determinations.

electrodes were painted on one side only with the paste. The quantity given above was found to be sufficient for coating 500 electrodes. The purpose of the coating was to prevent excessive oxidation of the metal of the electrode during fusion and to form also a thin protective coating of slag upon the fused metal.

Tension specimens only were prepared from the arc-fused metal. It is quite generally recognized that the tension test falls very short in completely defining the

TABLE IV. RELATION BETWEEN NITROGEN CONTENT AND CURRENT DENSITY*

Size of Elec. trode, In. (Approx)	Amperes	Current Density	Nitrogen Content (Per Cent)†			
			"A" Spec.	"B" Spec.	"C" Spec.	Average
1/8	110	9,000	0.156 0.149‡	0.152 0.141‡	.....	0.138
1/8	145	11,800	0.127 0.140‡	0.132 0.135‡	.....	0.126
1/4	145	7,600	0.140 0.121‡	0.124 0.122‡	.....	0.127
1/4	185	9,650	0.123 0.119‡	0.121 0.163‡	.....	0.131
1/2	225	11,700	0.124 0.113‡	0.117 0.123‡	.....	0.120
1/2	175	9,100	.....	.....	0.133 0.098	0.120
1/2	185	6,700	0.126 0.127‡	0.119 0.106‡	.....	0.120
1/2	225	8,150	0.131 0.131‡	0.111 0.108‡	.....	0.118
1/2	260	9,400	0.133 0.134‡	0.112 0.094	.....	0.114
1/2	300	3,900	0.117 0.111‡	.....	.....	0.114

* Credit due J. R. Cain.

† Average of two determinations.

‡ Included in average for C-D 11,800.

§ Coated electrodes.

¶ Included in average for C-D 9,000.

• Average of 9 determinations.

mechanical properties of any metal; it is believed, however, that the behavior of this material when stressed in tension is so characteristic that its general behavior under other conditions of stress, particularly when subjected to the so-called dynamic tests—i.e., vibration and shock—can be safely predicted from the results obtained.

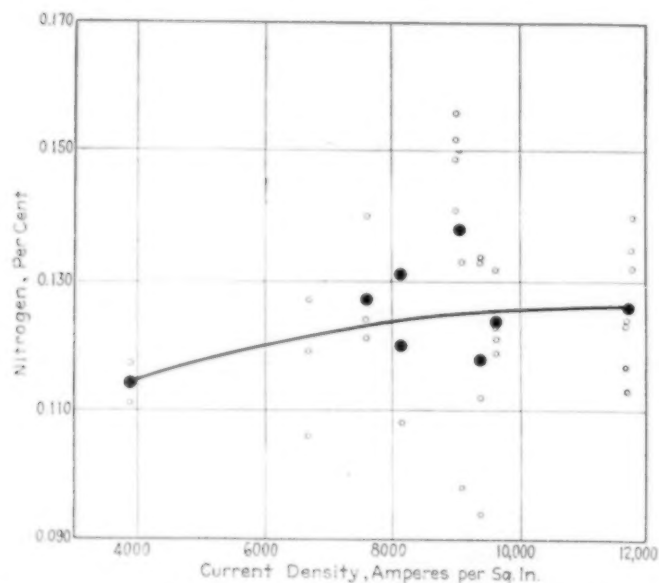


FIG. 4. RELATION OF CURRENT DENSITY TO NITROGEN CONTENT IN ARC-FUSED IRON
Black dots represent averages.

In order to supplement the specimens made at the Bureau a series of six were also prepared by one of the large manufacturers of equipment for electric welding to be included in the investigation. These are designated as "C" in the tables.

In Table III it will be noted that the general effect

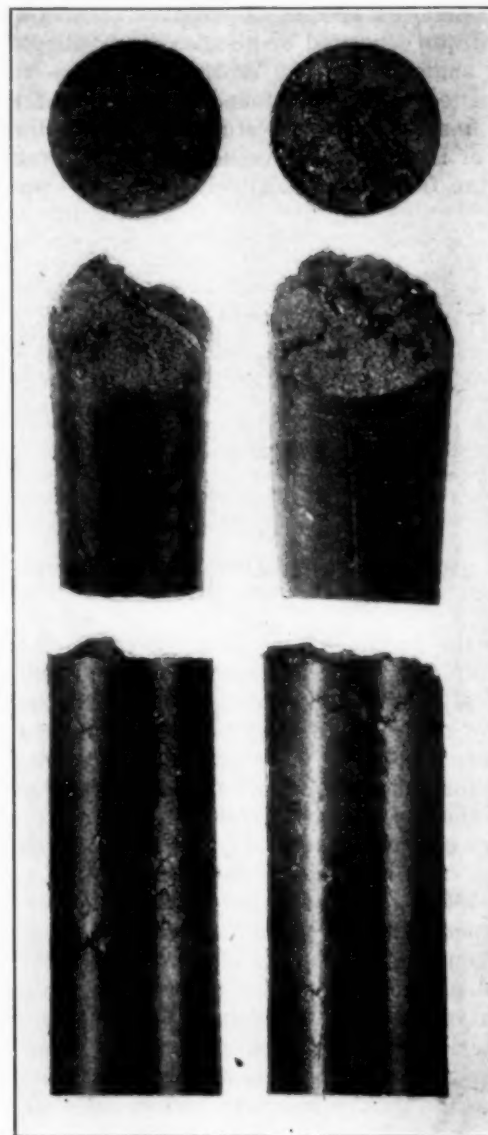


FIG. 5. CHARACTERISTIC APPEARANCE OF TENSION SPECIMEN AFTER TEST

At top, face of fracture, viewed normally. Middle, fractured end of specimen, viewed at an angle of 45 deg. At bottom, cylindrical surface of specimen. Magnification, $\times 2$.

of the fusion is to render the two materials used for welding pencils more nearly the same in composition. The loss of carbon and of silicon is very marked in each case where these elements exist in considerable amounts. A similar tendency may be noted for manganese. The coating with which the electrodes were covered appears to have but little influence, if any, in preventing the oxidation of the carbon and other elements.

The most noticeable change in composition is the increase in the nitrogen content of the metal. In general the increase was rather uniform for all specimens. In Table IV are summarized the results of the nitrogen

TABLE V. TENSILE PROPERTIES OF ELECTRODES

Electrode	Size, In.	Ult. Strength, Lb./Sq. In.	Proport. Limit, Lb./Sq. In.	Elong. in 2 In. Per Cent	Reduct. Area, Per Cent
A	1/8	65,800	39,000	16.5	69.2
A	1/8	62,100	48,000	9.0	69.3
A	1/4	60,100	34,500	14.0	66.4
A	1/4	57,300	.....	15.5	67.6
B	1/8	88,600	67,000	4.5	51.3
B	1/8	84,700	58,500	7.0	59.8
B	1/4	66,300	37,500	15.0	61.4
B	1/4	67,900	.....	15.5	62.4

TABLE VI. TENSILE PROPERTIES AND HARDNESS OF FIFTY SPECIMENS OF WELD-METAL PREPARED AT THE BUREAU. (0.505-IN. DIAM. STANDARD TENSION BAR USED)

Sample No.	Size Electrode, In.	Bare Electrodes				Elong. in 2 In., per Cent	Reduc. Area, per Cent	Brinell Hardness
		Tensile Properties			Proportional Limit			
		Amp., D. C.	Ult. Strength	Yield Pt.				
A2	1/8	110	49,850	36,600	25,000	6.0	6.5	108
A3	1/8	145	51,950	36,250	30,000	8.0	13.0	114
A7	1/8	145	47,550	.....	.....	6.0	7.4	108
A8	1/8	185	48,100	.....	.....	8.0	8.7	104
A9	1/8	225	45,500	.....	.....	8.0	9.6	101
A4	1/8	185	50,600	33,750	29,500	5.5	13.5	105
A5	1/8	225	49,150	36,250	22,000	7.0	10.0	102
A6	1/8	260	50,950	33,750	28,800	10.5	12.0	107
A10	1/8	300	46,670	.....	.....	12.0	11.9	104
Covered Electrodes								
AD2	1/8	110	51,250	35,000	25,600	9.5	11.0	103
AD2-D	1/8	110	43,000	.....	23,000	5.0	9.0	.....
AD3	1/8	145	51,100	33,750	25,000	8.5	10.5	110
AD3-D	1/8	145	46,250	.....	24,250	7.0	12.0	.....
AD7	1/8	145	41,750	.....	.....	6.0	6.6	99
AD7-D	1/8	145	46,950	.....	25,500	8.0	9.4	.....
AD8	1/8	185	44,620	.....	.....	6.5	5.8	103
AD8-D	1/8	185	43,600	.....	23,250	6.5	9.0	.....
AD9	1/8	225	46,900	.....	.....	9.5	10.1	96
AD9-D	1/8	225	41,550	.....	25,500	5.0	6.5	.....
AD4	1/8	185	51,200	35,000	30,000	10.5	10.5	101
AD4-D	1/8	185	45,700	.....	25,500	8.5	11.5	.....
AD5	1/8	225	48,600	35,000	30,000	7.0	10.0	96
AD5-D	1/8	225	46,250	.....	23,750	11.5	12.0	.....
AD6	1/8	260	47,500	34,500	31,500	9.0	9.0	97
AD6-D	1/8	260	50,700	.....	.....	8.0	2.8	105
AD10	1/8	300	45,900	.....	.....	8.5	11.5	98
Bare Electrodes								
B2	1/8	110	52,650	37,000	27,000	7.5	7.5	114
B3	1/8	145	54,500	36,000	27,000	12.5	12.0	106
B4	1/8	145	46,450	33,500	26,000	5.0	7.0	102
B5	1/8	185	49,600	34,250	27,000	7.5	9.0	108
B6	1/8	225	49,500	30,500	28,000	9.0	7.5	110
B7	1/8	185	47,550	.....	28,500	7.5	11.5	95
B8	1/8	225	42,900	.....	18,750	7.5	16.2	101
B9	1/8	260	47,500	.....	21,500	12.0	13.5	102
Covered Electrodes								
BD2	1/8	110	49,050	33,750	27,500	9.0	12.0	100
BD2-D	1/8	110	44,400	.....	20,000	6.5	9.4	.....
BD3	1/8	145	52,100	34,300	30,500	12.5	16.0	116
BD3-D	1/8	145	50,850	.....	23,500	13.0	17.5	.....
BD4	1/8	145	48,130	31,000	30,500	8.0	10.0	101
BD4-D	1/8	145	41,750	.....	21,000	6.0	9.5	.....
BD5	1/8	185	49,086	31,730	29,000	12.5	13.0	97
BD5-D	1/8	185	47,100	.....	22,500	11.0	12.5	.....
BD6	1/8	225	45,500	30,500	25,000	8.5	10.5	95
BD7	1/8	185	49,950	.....	24,500	11.5	21.5	98
BD7-D	1/8	185	51,150	.....	23,750	14.5	19.5	.....
BD8	1/8	225	41,500	.....	17,850	6.0	12.7	99
BD8-D(?)	1/8(?)	225(?)	48,750	.....	21,250	12.5	16.0	.....
BD9	1/8	260	46,350	.....	24,000	10.0	15.0	99
Bare Electrodes								
C1	1/8	175	48,650	32,650	23,000	12.0	19.1	.....
C2	1/8	175	45,200	32,400	23,000	7.5	16.6	.....
C3	1/8	175	49,720	32,650	25,000	9.0	13.6	.....
C4	1/8	175	54,500	32,500	25,000	11.0	17.5	118
C5	1/8	175	50,900	32,500	24,000	15.0	23.0	109
C6	1/8	175	50,500	33,500	23,000	12.0	16.0	.....

determinations together with the corresponding current density used for the fusion of the metal. In Fig. 4 the average nitrogen contents found for the different conditions of fusion are given and plotted against the corresponding current density. Though no definite conclusion seems to be warranted, it may be said that, in general, the percentage of nitrogen taken up by the fused iron increases somewhat as the current density increases. With the lowest current densities used the amount of nitrogen was found to decrease appreciably. Paterson⁷ reports an increase in nitrogen content under similar conditions.

MECHANICAL PROPERTIES OF THE ARC-FUSED METAL

The mechanical properties of the two types of electrodes used as determined by the tension test are summarized in Table V.

⁷Paterson, J. H., "Electric Welding," *Engineering*, vol. 107, pp. 285-8. A paper read before the Association of Engineering and Ship Building Draftsmen, Feb. 4, 1919.

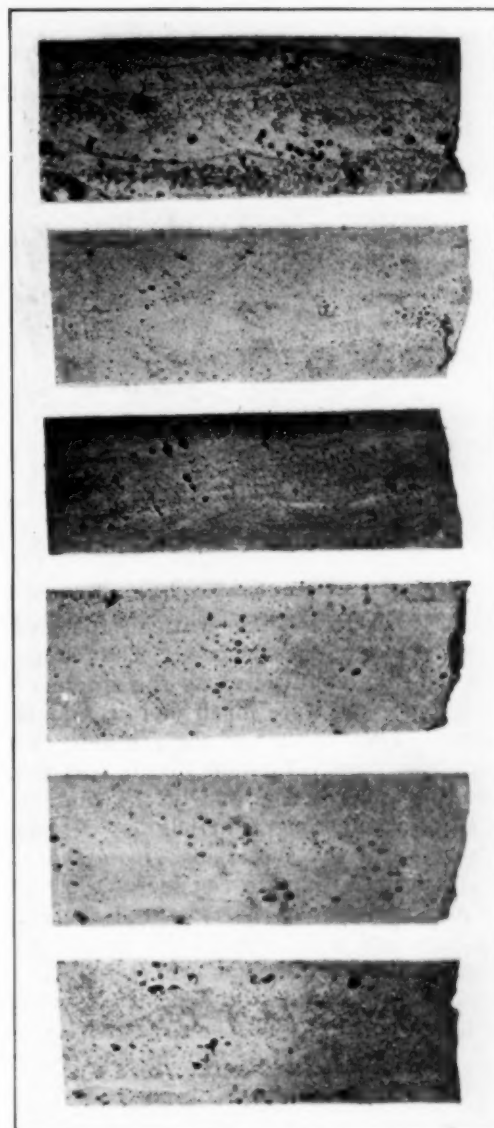


FIG. 6. MACROSTRUCTURE OF ARC-FUSED METAL, TYPE A

Medial longitudinal sections of the tension bars indicated were used (Table VI); etching, 10 per cent aqueous solution of copper-ammonium chloride. Magnification, $\times 2$. From top to bottom in order:

- AD6—A electrode; 1/8 in., covered, 260 amp.
- A5—A electrode; 1/8 in., bare, 225 amp.
- A6—A electrode; 1/8 in., bare, 260 amp.
- A3—A electrode; 1/8 in., bare, 145 amp.
- A4—A electrode; 1/8 in., bare, 185 amp.
- AD2—A electrode; 1/8 in., covered, 110 amp.

In Table VI are given the results of the mechanical tests made upon the tension specimens which were turned out of the blocks of metal resulting from the fusion of the electrodes.

The specimens listed, C₁, C₂, ..., C₆ are the six which were prepared outside the Bureau and submitted for purposes of comparison. It was stated that they were prepared from bare electrodes 1/8 in. diameter, of type "B," containing 0.17 per cent carbon and 0.5 per cent manganese.

As an aid for more readily comparing the mechanical properties of the two types of arc-fused metal "A" and "B," the results have been grouped as given in Table VII.

The characteristic appearance of specimens after testing, illustrating their behavior when stressed in tension till rupture occurs, is shown in Fig. 5. These represent two views of the face of the fracture, one in which the line of vision is perpendicular to the face, the other at

TABLE VII. TENSILE PROPERTIES AND HARDNESS OF FIFTY SPECIMENS OF WELD-METAL PREPARED BY THE BUREAU—ARRANGED IN ORDER OF AMPERAGE USED

Amperage	Tensile Properties								Elongation in 2 In.				Reduction of Area				Brinell Hardness					
	Ultimate Strength Lb. Sq. In.				Yield Point Lb. Sq. In.				per Cent				per Cent				A		B			
	A*		B*		A		B		A		B		A		B		Bare	Covered	Bare	Covered		
Used Amps.†	Bare	Covered	Bare	Covered	Bare	Covered	Bare	Covered	Bare	Covered	Bare	Covered	Bare	Covered	Bare	Covered	Bare Brin.	Covered Brin.	Bare Brin.	Covered Brin.		
110	49,850	51,250 43,000‡	52,650 44,000‡	49,050 36,600	35,000 37,000	33,750 34,300	6.0 6.0	9.5 7.5	6.5 6.5	11.0 9.0‡	12.0 9.4‡	108	103	114	100							
145	(1) 51,950	51,000	54,500	52,100	36,250	33,750	36,000	34,300	6.0	8.5	12.5	12.5	13.0	13.0	10.5	12.0	16.0	17.5‡	114	110	106	116
	(2) 47,550	46,250	46,450	50,850‡	33,500	31,000	33,500	31,000	6.0	7.0‡	12.5	13.0‡	13.0‡	12.0‡	10.5‡	12.0‡	16.0‡	17.5‡	114	110	106	116
185	(1) 48,100	41,750	46,450	48,130	33,500	31,000	34,250	31,730	6.0	6.0	5.0	8.0	6.0‡	7.4	6.6	7.0	10.0	9.5‡	108	99	102	101
	(2) 50,600	46,950	46,450	41,750‡	33,500	31,000	34,250	31,730	8.0	8.0	7.5	8.0	6.0‡	7.4	6.6	7.0	10.0	9.5‡	108	99	102	101
225	(1) 45,500	44,620	49,600	49,086	34,250	31,730	34,250	31,730	8.0	6.5	7.5	12.5	11.0‡	8.7	5.8	9.0	13.0	12.5‡	104	103	108	97
	(2) 49,150	43,600	49,600	47,100‡	34,250	31,730	34,250	31,730	5.5	6.5‡	7.5	11.0‡	11.0‡	8.7	5.8	9.0	13.0	12.5‡	104	103	108	97
260	(1) 45,500	51,200	47,550	49,950	33,750	35,000	30,500	30,500	5.5	10.5	7.5	11.5	14.5‡	13.5	10.5	11.5	21.5	19.5‡	105	101	95	98
	(2) 49,150	45,700	47,550	51,150‡	33,750	35,000	30,500	30,500	8.0	8.5‡	7.5	11.5‡	14.5‡	13.5	10.5‡	11.5‡	21.5‡	19.5‡	105	101	95	98
300	(1) 45,500	46,900	49,500	45,500	35,000	30,500	30,500	30,500	8.0	9.5	9.0	8.5	9.6	10.1	7.5	10.5	10.1	9.6	110	96	110	95
	(2) 49,150	41,550	42,900	41,500	36,250	34,500	34,500	34,500	7.0	5.0‡	7.5	6.0	10.0	6.5‡	16.2	12.7	9.6	9.6	101	96	110	95
Average	(1) 45,500	48,600	42,900	41,500	36,250	35,000	34,500	34,500	7.0	7.0	7.5	6.0	10.0	10.0	16.2	12.7	96	96	101	99		
	(2) 49,150	46,250	42,900	41,500	36,250	35,000	34,500	34,500	10.5	11.5‡	7.5	6.0	10.0	10.0	16.2	12.7	96	96	101	99		
260	50,950	47,500	47,500	46,350	33,750	34,500	34,500	34,500	10.5	9.0	12.0	10.0	12.0	9.0	13.5	15.0	107	97	102	99		
300	46,670	50,700	45,900	33,750	34,500	34,500	34,500	34,500	12.0	8.0‡	12.0	10.0	12.0	2.8‡	13.5	15.0	107	97	102	99		
Average	48,900	46,600	48,800	47,450	35,300	34,650	34,250	32,250	7.9	8.5	8.5	9.9	10.3	9.2	10.5	13.8	104	100	105	101		
	Av.	47,400	Av.	47,980	Av.	35,000	Av.	33,250	Av.	7.9	Av.	9.0	Av.	9.6	Av.	12.5	Av.	103	Av.	103		

* A and B refer to the two types of electrodes used (Table III).

† Size of electrode used: $\frac{1}{8}$ in. diam. — 110 amp. and 145 (1) amp. $\frac{1}{16}$ in. diam. — 145 (2) amp., 185 (1) amp. and 225 (1) amp. $\frac{1}{8}$ in. diam. — 185 (2) amp., 225 (2) amp.

‡ Duplicate specimen.

an angle of 45 deg., together with a side view of the cylindrical surface of the specimen. The features shown in Fig. 5 are characteristic of all the specimens tested, though in some they were much more pronounced than those shown. The fracture of the specimen in all cases reveals interior flaws. In some of the specimens, however, these are microscopic and of the character to be discussed in a subsequent article on Metallography. Although many of the specimens (from the results of Table VI) appear to have a considerable elongation, it is seen from Fig. 5 that the measured elongation does not truly represent a property of the metal itself. It is due rather to interior defects which indicate lack of perfect union of succeeding additions of metal during the process of fusion. The surface markings of the specimen after stressing to rupture are very similar to those seen in the familiar "flaky steel."

RESULTING PHYSICAL PROPERTIES DEPEND ESSENTIALLY ON SOUNDNESS

It appears from the results above that, as far as the mechanical properties are concerned, nothing was gained by coating the electrodes. The results show no decided superiority for either of the two types of electrodes used. This may be expected, however, when one considers that the two are rendered practically the same in composition during fusion by the burning out of the carbon and other elements.

The results of the tension tests upon the "C" series of specimens which were made outside of the Bureau and submitted to be included in the investigation show no marked difference between these samples and those prepared by the Bureau. In all cases the results obtained in the tension test are determined by the sound-

ness of the metal and do not necessarily indicate the real mechanical properties of the material. The results of the hardness determinations do not appear to have any particular or unusual significance. The variations are of the same general nature and relative magnitude as the variations observed in the results of the tension test. In general the higher hardness number accompanies the higher tensile values, though this was not invariably so. As previously noted, specimens were prepared for the purpose of showing the relation between the direction in which the stress is applied and the manner of deposition of the metal. The metal was deposited in the form shown in Fig. 3, except that the "beads" extended across the piece rather than lengthwise, hence the "beads" of fused metal were at right angles to the direction in which the tensional stress was applied. The results of the tension tests show that these two specimens (AW₁ and AW₂) were decidedly inferior to those prepared in the other manner as shown in Table VIII.

MACROSTRUCTURE

The general condition of the metal resulting from the arc-fusion is shown in Figs. 6 and 7, which show longitudinal median sections of a series of the tension bars adjacent to the fractured end. The metal in all of these specimens was found to contain a considerable number of cavities and oxide inclusions; these are best seen after the surfaces are etched with a 10 per cent aqueous solution of copper-ammonium chloride. In many of the specimens the successive additions of metal are outlined by a series of very fine inclusions (probably oxide) which are revealed by the etching. There appears to be no definite relation between the soundness of the metal and the conditions of deposition—i.e., for the range of current density used—nor does either type of electrode used show any decided superiority over the other with respect to porosity of the resulting fusion. In Fig. 8 is shown the appearance of a cross-section of one of the blocks of arc-fused metal prepared outside of the Bureau by skilled welding operators. The condition of this material is quite similar to that prepared by the Bureau.

The microscopic study of the material to be discussed in a subsequent article also revealed further evidence of unsoundness in all three types, "A," "B" and "C."

DISCUSSION OF RESULTS

In any consideration of electric-arc welding it should constantly be borne in mind that the weld-metal is simply metal which has been melted and has then solidified

TABLE VIII. MECHANICAL PROPERTIES OF ARC-FUSED METAL DEPOSITED AT RIGHT ANGLES TO LENGTH OF SPECIMEN

Specimen	Ult. Strength, Lb. / Sq. In.	Proportional Limit, ■ Lb. / Sq. In.	Elongation in 2 In. (per Cent)	Red. of Area, per Cent
AW ₁	40,450	22,500	6.5	8.5
AW ₂	39,500	22,500	4.0	3.0

ness of the metal and do not necessarily indicate the real mechanical properties of the material.

The results of the hardness determinations do not appear to have any particular or unusual significance. The variations are of the same general nature and rela-

in situ. The weld is essentially a casting, though the conditions for its production are very different from those ordinarily employed in the making of steel castings. The metal loses many of the properties it possesses when in the wrought form and hence it is not to be expected that a fusion weld made by any process whatever will have all the properties that metal of the same composition would have when in the forged or rolled condition. A knowledge of the characteristic properties of the arc-fused iron is, then, of fundamental importance in the study of strength and reliability of the electric-arc weld.

The peculiar conditions under which the fusion took place also render the metal of the weld quite different from similar metal melted and cast in the usual manner. It is seemingly impossible to fuse the metal without serious imperfections. The mechanical properties of the metal are dependent therefore to an astonishing degree upon the skill, care and patience of the welding operator. The very low ductility shown by specimens

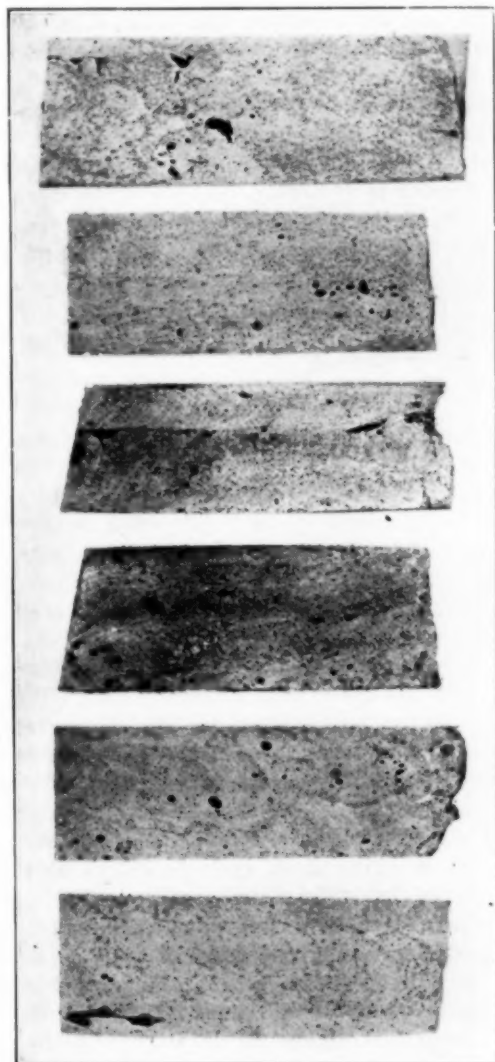


FIG. 7. MACROSTRUCTURE OF ARC-FUSED METAL, TYPE B

Medial longitudinal sections of the tension bars indicated were used (Table VI); etching, 10 per cent aqueous solution of copper-ammonium chloride. Magnification, $\times 2$. From top to bottom in order:

- B4—B electrode; $\frac{1}{8}$ in., bare, 145 amp.
- B5—B electrode; $\frac{1}{8}$ in., bare, 185 amp.
- B2—B electrode; $\frac{1}{8}$ in., bare, 110 amp.
- B3—B electrode; $\frac{1}{8}$ in., bare, 145 amp.
- BD6—B electrode; $\frac{1}{8}$ in., covered, 225 amp.
- BD4—B electrode; $\frac{1}{8}$ in., covered, 145 amp.



FIG. 8. MACROSTRUCTURE OF ARC-FUSED METAL, TYPE C

Specimen C1 (Table VI), cross-section of the block of arc-fused metal from which the tension bar was turned; etched with 5 per cent alcoholic solution of picric acid. Magnification, $\times 1.7$.

when stressed in tension is the most striking feature observed in the mechanical properties of the material as revealed by the tension test. As explained above, the measured elongation of the tension specimen does not truly indicate a property of the metal. Due to the unsoundness, already described in the discussion of the structure, the true properties of the metal are not revealed by the tension test to any extent. The test measures, largely for each particular specimen, the adhesion between the successively added layers, which value varies considerably in different specimens due to the unsoundness caused by imperfect fusion, oxide and other inclusions, tiny enclosed cavities and similar undesirable features. The elongation measured for any particular specimen is therefore due largely, if not entirely, to the increase of length due to the combined effect of the numerous tiny imperfections which exist throughout the sample.

That the metal is inherently ductile, however, is shown by the behavior upon bending (later to be discussed) in the microstructure of bent specimens. The formation of slip-bands within the ferrite grains to the extent which was observed is evidence of a high degree of ductility. It appears, however, that the grosser imperfections are sufficient to prevent any accurate measurement of the real mechanical properties of the metal from being made. The conclusion appears to be warranted therefore that the changes of chemical composition which the fusion entails, together with the unusual features of microstructure which accompany the composition change are of but minor importance in determining the strength, durability and other properties of the arc weld.

In arc-fusion welds in general, the mass of weld-metal is in intimate contact with the parts which are being welded so that it is claimed by many that because of the diffusion and intermingling of the metal under repair with that of the weld, properties of the latter are considerably improved. The comparison shown in Table IX somewhat supports this claim. The nearest com-

parison found available with the Bureau's specimen are some of those of the welds designated as the "Wert-Jones" series reported by H. M. Hobart.⁴ These welds were of the 45 deg. double-V type made in $\frac{1}{2}$ -in. ship plate; the specimens for test were of uniform cross-section $1 \times \frac{1}{2}$ in., the projecting metal at the joint having been planed off even with the surface of the plates, and the test bars were so taken that the weld extended transversely across the specimen near the center of its length. The electrodes used in the Wert-Jones series were similar to those designated as type "B" in the Bureau's investigation.

Since the specimens used in work described in the foregoing sections were prepared in a manner quite

TABLE IX. COMPARISON OF WELDS WITH TESTS OF ARC-FUSED METAL PREPARED UNDER SIMILAR CONDITIONS

Bureau of Standards				Wert-Jones			
Size Electrode, In.	D.C. Amp.	Ult. Strength, Lb./Sq. In.	Elong. Per Cent per 2 In.	Size Electrode, In.	D.C. Amp.	Ult. Strength, Lb./Sq. In.	Elong. Per Cent per 2 In.
$\frac{1}{8}$	110	52,650	7.5	$\frac{1}{8}$	110	45,800	8.0
$\frac{1}{4}$	110	49,050	9.0	$\frac{1}{4}$	115	58,200	14.0
$\frac{3}{8}$	110	44,400	6.5	$\frac{3}{8}$	115	59,400	13.5
Average		48,700	7.7	$\frac{1}{2}$	120	53,700	7.0
$\frac{1}{2}$	145	46,450	5.0	$\frac{1}{2}$	120	57,600	8.5
$\frac{5}{8}$	145	48,130	8.0	Average		54,940	10.2
$\frac{3}{4}$	145	41,750		$\frac{3}{4}$	150	60,900	8.0
Average		45,440	6.3	$\frac{7}{8}$	155	62,600	11.5
$\frac{7}{8}$	185	49,600	7.5	Average		61,750	9.8
$\frac{1}{16}$	185	49,080	12.5	$\frac{1}{16}$	175	59,800	9.0
$\frac{1}{8}$	185	47,100	11.0				
Average		48,395	10.3				

* Electrodes were used in bare condition.

† Electrodes were coated as previously described, those not so designated in this column were used bare.

different from the usual practice of arc-welding, no definite recommendations applicable to the latter can be made.

It appears, however, from the results obtained that the two types of electrodes used—i.e., "pure" iron and low-carbon steel—should give very similar results in practical welding. This is due to the changes which occur during the melting so that the resulting fusions are essentially of the same composition. The use of a slight coating on the electrodes does not appear to be of any material advantage so far as the properties of the resulting fused metal are concerned. Since the program of work as carried out did not include the use of any of the covered electrodes which are highly recommended by many for use in arc welding, particularly for "overhead work," no data are available as to the effect of such coatings upon the properties of the metal resulting from fusion. Although all of the specimens used in the examinations were made by the use of direct current, it appears from the results obtained with a considerable number of welds representing the use of both kinds of current, submitted for the preliminary examinations which were made, that the properties of the fused metal are independent of the kind of current and are influenced primarily by the heat of fusion. Any difference in results obtained by welding with alternating current as compared with those obtained with direct current apparently depends upon the relative ease of manipulation during welding rather than to any intrinsic effect of the current upon properties of the metal.

⁴H. M. Hobart, "Welding Mild Steel," Bulletin 146, American Institute of Mining Engineers, p. 517; Bulletin 148, p. 752; Bulletin 149, p. 810; Bulletin 150, p. 931.

Drawing in Saltpeter

By V. E. HILLMAN

Molten Chilean saltpeter is an excellent drawing medium in view of the fact that the baths can be worked safely between the range of 800 and 1,200 deg. F.

Although sodium nitrate has found extensive use in the majority of heat-treating departments, it is not uncommon to find foremen who are unfamiliar with its application. When hardened steel is immersed in a molten saltpeter bath for fifteen minutes, an excellent spring temper is developed. The bath has unusual merit, due to the uniformity of the finished product. Small work especially can be drawn to advantage inasmuch as a basketful of hardened material can be immersed as a unit. This method of procedure insures high production and the development of a spring that will neither set nor break.

The proper drawing temperature is a function of the size of the work to be tempered as well as the chemical composition and the desired temper. Generally speaking, 900 deg. F. can be used for various classes of work. In special cases the temperature of the bath may have to be raised or lowered, to meet existing conditions.

An ordinary cyanide furnace which will accommodate an iron pot 26 in. long by 15 in. wide by 12 in. deep is suitable for heating purposes. A large volume of molten saltpeter is desirable, because when work is immersed therein, there is a tendency for the temperature of the bath to drop appreciably. The life of a cast-iron pot is approximately two months. The casting, however, should be free from porosity and sound throughout. Special alloys can be used to advantage if a longer life is desired.

Worcester, Mass.

Cinnamon Industry in Ceylon

Although cinnamon is produced in various parts of the tropics, the best quality is produced in Ceylon, according to an article in the *World Salesman*. Owing to its peculiar climatic conditions, Ceylon is particularly adapted to the growing of the cinnamon tree, which requires an annual rainfall of 85 to 100 in. and an average temperature of 85 deg. The tree has a very long life and has often been known to attain the height of 40 ft. Every second year the shoots are cut from the tree, four to seven usually being obtained. After being subjected to a process of sweating the bark is peeled from the shoots and then softened to remove the outer skin. This outer skin is of second quality, the middle section being first, and the inner and thicker section of the bark the third quality. The pieces of bark are turned concave side downward to dry and in drying contract, taking the form of rolls or quills, the smaller ones being fitted into the larger ones, making what are known as "pipes," about 3 ft. in length. These are then packed into bales for shipment. Little of pure cinnamon in stick form is consumed in the United States, the greater part going to the Latin countries—Spain, Mexico, Central and South America—in which countries it is used in preparation of various foods. Cinnamon and cassia are ground and appear on the market as ground cinnamon. Cinnamon oil, which is quite extensively used in perfumes and medicines, is chiefly made in Ceylon from inferior pieces of bark, chips and broken quills.

The Flow of Oil in Pipes—II

A General Method for Determining the Friction Loss of Any Liquid From Its Saybolt Viscosity; With Tables for Pipes From One to Six Inches in Diameter*

BY ARTHUR C. PRESTON

IN FIG. 1 (b) it will be noticed that points A, representing velocity at the Reynolds criterion $\frac{v \rho d}{\mu} = 2,050$, and points B, representing the post-criterion $\frac{v \rho d}{\mu} = 2,900$, fall on a line of slope 3, which coincides with those branches of the logarithmic plotting which give values of $\log h$ between these two criteria. It may be proved that all points, such as A or B, representing equal values of $\frac{v \rho d}{\mu}$, must necessarily fall on a line of slope 3; and since the values of $\frac{v \rho d}{\mu}$ chosen to determine A and B respectively were such that the line between them has this same slope, it follows that the points A and B, and the lines AB, all fall on the same straight line. If slightly different values of the criteria had been used, points A and points B respectively would have fallen on lines of slope 3 as before, but the lines AB would have had a different slope, and would not have overlapped.

This feature of Fig. 1 is rather confusing, because it appears to indicate that, in the region where overlapping occurs, pipes of two different sizes may have equal friction losses at equal velocities—a thing which is not normally true; but this occurs only over a very short range in the region of unsteady flow, and it will be remembered that the relation shown by the lines AB in this region is only an approximation to fact; that the variation of friction loss with velocity during unsteady flow does not follow any definite rule, and that such conflicting phenomena as the one referred to actually are observed in experimental work.

In following through the tables it will be found that in general as viscosity increases, with a given diameter and discharge, friction head at first increases; then momentarily decreases; and finally increases again, continuing to increase with further increase of viscosity. This effect is due to the suppression of eddying between the points of critical and post-critical velocity. Starting with a liquid of low viscosity, and consequent high value of the criterion, the flow at first is eddy-

ing. As $\frac{\mu}{\rho}$ increases the value of the criterion decreases until it reaches the post-critical value of 2,900. Since eddying suddenly begins to disappear at this point, the total friction loss decreases by the amount which formerly was due to the resistance of the eddies. This action continues until the critical value, 2,050, is reached. After that, the eddying being completely suppressed, there is no further elimination of eddy losses. The subsequent flow is steady, and from this

point on there is a regular increase of friction head from the increasing viscosity resistance.

The same point may be illustrated by drawing a horizontal line on Fig. 3 in such a way as to intersect all three branches of the curve. It will be evident that the same value of f holds for three different values of $\frac{v \rho d}{\mu}$; and when, for a given diameter and discharge, v and d are constant, it follows that the same value of h holds for three slightly different values of kinematic viscosity. In using the tables it will be wise to observe how friction head varies with both increase and decrease of viscosity, to avoid a possible error in this connection.

For example, if it were desired to pump the transformer oil No. 2 of Fig. 4 at the rate of 30 gal. per min. through 1-in. pipe in an outdoor transformer station where the lowest winter temperature is assumed as + 16 deg. F., it would be natural to assume that since the viscosity is a maximum at the minimum temperature, the friction loss would then be greatest, and would determine the maximum requirement for pumping pressure. By reference to the curve the viscosity at 16 deg. F. is seen to be 200 Saybolt, and from the table for 1-in. pipe, viscosity 200, the friction loss is found to be 95.5 ft. per 100 ft. of pipe. This, however, is not the maximum possible; for by further inspection of the tables it is found that at a viscosity of only 150, corresponding to a temperature of 25 deg., the friction head is 121.4, or about 25 per cent greater, although at a temperature 9 degrees higher and more likely to occur. The latter therefore is the value which must govern the provision made for pumping pressure. This result at first sight appears confusing. The condition cannot be ignored, since it is based on the fundamental laws of flow; but it will not cause trouble if it is clearly understood and the possibility of its occurrence kept in mind.

The following paragraph, quoted from Prof. Flowers, refers to the early observation and study of this phenomenon:

"Hagen, a German physicist and engineer, published in 1854 an account of a number of tests he had made on the flow of water through fairly large tubes. These results were plotted in the form of curves with velocity at some given pressure as ordinates and temperature as abscissas. These curves showed a very remarkable effect in view of the (even then) well-known fact that the viscous resistance of liquids decreases with rise of temperature. At some point, occurring at lower temperature for greater pressures, the velocity not only ceased to increase with further rise of temperature, but fell off, and after reaching a minimum began once more to increase, but at a slower rate. A satisfactory explanation of this critical velocity was not given until

*For Part I see CHEM. & MET. ENG., vol. 23, No. 13, 1920, p. 607.

the appearance in 1883 of the work of Prof. Osborne Reynolds."

This was the same phenomenon with which we have been dealing, stated in inverse terms—that is, with regard to the effect of the development of eddying on velocity at constant pressure, instead of with regard to the suppression of eddying on pressure at constant velocity.

TEMPERATURE AN IMPORTANT FACTOR OF VISCOSITY

In Fig. 4 are given temperature-viscosity curves for a number of the oils which are most commonly transmitted through pipes in industrial plants; these include transformer, turbine and fuel oils, and are not intended for reference in actual design, but merely to indicate the range of viscosity which may be met in handling these various types of oil.

The usual method of specifying fuel oil is by its Baumé gravity. This in itself indicates nothing as to viscosity and friction loss of the oil. In general there is no constant relation between viscosity and specific gravity; there may be a certain correspondence between

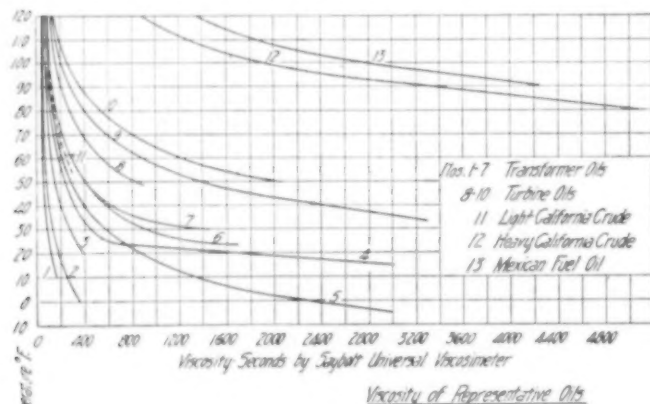


FIG. 4. TEMPERATURE VISCOSITY CURVES

the two for crude or residual oils from the same field, but the relation is completely lost when dealing with refined and blended oils. The only rational basis for determining oil friction losses is a knowledge either of the Saybolt viscosity or of the absolute viscosity and density, for the particular oil in question at the temperature which is assumed to govern for the given case. With these data in hand a close approximation may be made to the loss for the assumed condition, which of course will only occasionally be realized in practice. If the pipe sizes are chosen large enough for the most severe temperature requirement, they will be ample for more favorable conditions.

When the oil is to be heated before entering the pipe, so as to cool continually during flow, it is possible to make an approximate estimate of the friction loss with the help of tables, which may be found in engineering handbooks, giving the rate of heat transference through standard iron pipes per degree of temperature difference. Assuming an initial temperature of oil and a minimum outside temperature, and dividing the pipe into parts of convenient length for purposes of computation, the heat loss may be determined for the first length of pipe at the assumed temperature difference. Remembering that the specific heat of oil is about 0.42° the average temperature of the oil in that length may be obtained, from which the viscosity and finally the

friction loss may be determined. Proceeding thus, the temperature difference and heat loss decreasing for each succeeding length, the total of all the partial friction losses may be summed up for the pipe as a whole. But extreme precision in such a computation should not be attempted, for the temperature and viscosity of the oil will not vary from length to length of pipe exactly in the manner assumed. Cooling is felt first around the wall of the pipe, and a comparatively viscous mass forms here, while the interior portion remains more fluid; so that the assumption of constant temperature and viscosity throughout the cross-section at a given point is not strictly true, and an ample allowance for these uncertainties is required.

CHECK OF PRINCIPLES ESTABLISHED ON WATER AND OIL

Since the method which has been described is general for all fluids it ought of course to give correct results when applied to water, and as the friction losses of water flowing in pipes are well established, this should furnish a means of checking the accuracy of the method. Since, however, no data were at hand for water in drawn piping, which is smoother than wrought or cast iron pipe, the comparison was made by means of equation (9), which refers to clean wrought-iron pipe. The value used for the absolute viscosity of water at 68 deg. F. was 0.001005 dynes per sq.cm., and

its density 0.99826, which gives $\frac{\mu}{\rho} = 0.0001082$ in English units. The losses for such pipe were found to be greater than our tabular values for drawn pipe by about the following percentages:

Pipe diameter, in.	1	2	3	4	5	6
Excess for wrought iron pipe, per cent.	12	9	7	5	4	3

In the absence of more complete comparative data, or until a parallel course of experimentation shall be carried out on commercial iron pipe, these figures may serve as a roughness correction to be applied to the tabular values as given for drawn pipe, in order to adapt them for the computation of wrought-iron pipe.

The tabular values have been compared also with experimental data on pipe friction losses for a light

FRICITION HEAD IN FEET PER HUNDRED FEET OF PIPE

Water at 20 Deg. C. = 68 Deg. F.

$$\frac{\mu}{\rho} = 0.0001082 \text{ pounds sq.ft.}$$

Gal. per Min.	Drawn Steel or Brass Pipe, Actual Diameter, Inches					
	1	2	3	4	5	6
5	2.20					
10	7.33	0.27	0.04			
15	14.81					
20	25.08	0.91	0.13	0.03	0.01	0.01
25	37.40					
30	51.30	1.84	0.26			
35	67.70					
40	86.45	3.11	0.44	0.11	0.04	0.02
45	107.80					
50	130.20	4.60	0.66			
60		6.35	0.91	0.23	0.08	0.04
70		8.45	1.20			
80		10.68	1.51	0.39	0.13	0.06
100		16.20	2.30	0.58	0.20	0.08
125		24.15	3.43	0.85	0.30	0.12
150		33.10	4.82	1.19	0.41	0.17
175		43.20	6.32	1.58	0.55	0.23
200		55.40	7.95	2.02	0.69	0.29
225		69.10	9.75	2.48	0.86	
250		85.40	11.78	3.02	1.04	0.43
275		103.20	13.93	3.53	1.24	
300		122.80	16.38	4.10	1.45	0.61
325				4.73		
350				5.42	1.88	0.80
375				6.12		
400				6.88	2.40	1.01
450					2.98	1.25
500					3.55	1.47
550						1.77
600						2.03

*J. R. Battle, "Lubricating Engineer's Handbook," p. 138, J. B. Lippincott, Philadelphia.

FRICTION HEAD IN FEET PER HUNDRED FEET OF PIPE

Viscosity = 50 — Saybolt Universal Viscosimeter							Viscosity = 200 — Saybolt Universal Viscosimeter						
Gal. per Min.	Drawn Steel or Brass Pipe, Actual Diameter, Inches						Gal. per Min.	Drawn Steel or Brass Pipe, Actual Diameter, Inches					
	1	2	3	4	5	6		1	2	3	4	5	6
5	2.00						5	13.60					
10	12.40	0.31	0.06				10	27.20	1.69	0.33			
15	25.00						15	40.80					
20	41.35	1.53	0.21	0.04	0.02	0.01	20	54.40	3.38	0.66	0.21	0.09	0.04
25	61.40						25	68.00					
30	83.50	3.08	0.45				30	95.20	5.07	0.99			
35	109.60						35	149.60					
40	138.00	5.12	0.74	0.19	0.07	0.03	40	217.00	6.76	1.32	0.42	0.17	0.08
45	168.60						45	266.00					
50	203.50	7.57	1.10				50		8.45	1.65			
60		10.40	1.50	0.38	0.14	0.06	60		11.81	1.98	0.63	0.26	0.13
70		13.58	1.97				70		18.80	2.31			
80		17.14	2.48	0.64	0.23	0.10	80		26.95	2.64	0.84	0.34	0.17
100		25.20	3.72	0.95	0.34	0.14	100		40.00	4.75	1.05	0.44	0.21
125		37.08	5.48	1.39	0.49	0.20	125		59.00	8.60	1.60	0.54	0.26
150		50.80	7.46	1.91	0.67	0.28	150		81.10	11.85	2.88	0.76	0.32
175		66.50	9.78	2.49	0.87	0.37	175		105.20	15.51	3.98	1.22	0.41
200		85.00	12.30	3.14	1.10	0.46	200		133.30	19.60	4.97	1.77	0.63
225		103.50	15.15	3.84	1.35		225		164.20	24.05	6.10	2.13	
250		124.40	18.10	4.66	1.62	0.69	250		197.60	28.70	7.45	2.56	1.08
275			21.48	5.46	1.90		275			33.81	8.67	3.03	
300			25.20	6.32	2.22	0.94	300			39.60	10.10	3.52	1.50
325				7.26			325				11.52		
350				8.28	2.91	1.23	350				13.10	4.59	1.94
375				9.35			375				14.78		
400				10.57	3.65	1.56	400				16.50	5.80	2.47
450					4.52	1.91	450					7.15	3.03
500					5.45	2.28	500					8.50	3.62
550						2.72	550						4.30
600						3.17	600						5.00

Viscosity = 100 — Saybolt Universal Viscosimeter

Gal. per Min.	1	2	3	4	5	6
5	6.38					
10	12.76	0.80	0.16			
15	26.00					
20	55.90	1.60	0.32	0.10	0.04	0.02
25	79.10					
30	108.20	3.23	0.48			
35	141.60					
40	178.50	6.65	0.64	0.20	0.08	0.04
45	219.50					
50	264.00	9.75	1.29			
60		13.42	1.93	0.41	0.12	0.06
70		17.60	2.55			
80		22.12	3.21	0.83	0.25	0.09
100		32.85	4.80	1.23	0.44	0.16
125		48.60	7.09	1.80	0.63	0.26
150		66.90	9.76	2.47	0.87	0.37
175		87.00	12.70	3.24	1.14	0.48
200		109.20	16.10	4.08	1.43	0.61
225		134.20	19.85	5.00	1.74	
250		161.60	23.73	6.10	2.10	0.89
275			28.10	7.20	2.48	
300			32.80	8.30	2.89	1.22
325				9.53		
350				10.82	3.81	1.60
375				12.15		
400				13.63	4.80	2.03
450					5.87	2.50
500					7.00	2.96
550						3.54
600						4.12

Viscosity = 300 — Saybolt Universal Viscosimeter

Gal. per Min.	1	2	3	4	5	6
5	20.70					
10	41.40	2.57	0.51			
15	62.10					
20	82.80	5.14	1.02	0.32	0.13	0.06
25	103.50					
30	124.20	7.71	1.53			
35	144.90					
40	165.60	10.28	2.04	0.64	0.26	0.13
45	216.50					
50		12.85	2.54			
60		15.42	3.06			
70		18.00	3.57	0.96	0.39	0.19
80		20.56	4.08	1.28	0.52	0.26
100		36.75	5.08	1.60	0.66	0.32
125		65.30	6.35	2.00	0.82	0.40
150		91.00	10.97	2.40	0.99	0.48
175		118.50	17.00	2.92	1.15	0.56
200		150.50	21.90	4.57	1.32	0.64
225		183.00	26.90	6.46	1.70	
250		219.50	32.05	8.22	2.37	0.80
275			37.83	9.64	3.09	
300			44.20	11.23	3.92	1.38
325				12.95		
350				14.70	5.16	2.14
375				16.57		
400				18.58	6.47	2.76
450					7.96	3.35
500					9.52	4.04
550						4.80
600						5.56

Viscosity = 150 — Saybolt Universal Viscosimeter

Gal. per Min.	1	2	3	4	5	6
5	10.10					
10	20.20	1.25	0.25			
15	30.30					
20	40.40	2.50	0.50	0.16	0.07	0.03
25	75.16					
30	121.40	3.75	0.75			
35	161.00					
40	202.00	5.00	1.00	0.32	0.13	0.06
45	247.00					
50		9.33	1.25			
60		15.12	1.50	0.48	0.19	0.09
70		19.70	2.17			
80		24.90	3.31	0.64	0.26	0.13
100		37.10	5.38	1.18	0.33	0.16
125		54.30	7.95	2.02	0.62	0.19
150		74.50	10.96	2.78	0.97	0.36
175		97.60	14.35	3.65	1.28	0.53
200		124.00	18.10	4.61	1.60	0.68
225		152.00	22.10	5.67	1.97	
250		183.00	26.70	6.82	2.38	1.00
275			31.40	8.00	2.80	
300			36.70	9.26	3.25	1.39
325				10.75		
350				12.23	4.25	1.80
375				13.70		
400				15.43	5.36	2.27
450					6.62	2.78
500					7.95	3.35
550						3.98
600						4.63

Viscosity = 400 — Saybolt Universal Viscosimeter

Gal. per Min.	1	2	3	4	5	6
5	27.70					
10	55.40	3.44	0.68			
15	83.10					
20	110.80	6.88	1.36	0.43	0.18	0.09
25	138.50					
30	166.30	10.32	2.04			
35	193.90					
40	221.60	13.76	2.72	0.86	0.36	0.17
45						
50		17.20	3.40			
60		20.64	4.08	1.29	0.54	0.26
70		24.08	4.76			
80		27.52	5.44	1.72	0.73	0.34
100		34.40	6.80	2.15	0.89	0.43
125		53.10	8.50	2.69	1.11	0.53
150		91.20	10.20	3.23	1.33	0.64
175		127.10	12.80	3.77	1.55	0.75
200		161.20	19.06	4.31	1.78	0.85
225		197.00	27.30	4.85	2.00	
250		238.00	34.60	6.61	2.22	1.07
275			40.70	8.63	2.42	
300			47.70	11.72	2.82	1.28
325				13.90		
350				15.85	4.79	1.55
375				17.85		
400				20.10	6.95	2.40
450					8.57	3.37
500					10.25	4.30
550						5.16
600						5.96

FRICTION HEAD IN FEET PER HUNDRED FEET OF PIPE

Viscosity = 500 — Saybolt Universal Viscosimeter						
Gal. per Min.	Drawn Steel or Brass Pipe, Actual Diameter, Inches					
	1	2	3	4	5	6
5	34.60					
10	69.20	4.30	0.85			
15	103.80					
20	138.40	8.60	1.70	0.54	0.22	0.11
25	173.00					
30	207.60	12.90	2.55			
35	242.20					
40		17.20	3.40	1.08	0.44	0.22
45						
50		21.50	4.25			
60		25.80	5.10	1.62	0.66	0.33
70		30.10	5.95			
80		34.40	6.80	2.16	0.88	0.44
100		43.00	8.50	2.69	1.10	0.54
125		53.75	10.62	3.36	1.37	0.67
150		62.20	12.75	4.03	1.64	0.81
175		115.00	14.87	4.70	1.91	0.94
200		171.20	17.00	5.37	2.18	1.08
225		209.20	21.50	6.04	2.45	
250		252.50	29.40	6.71	2.72	1.35
275			39.00	7.38	2.99	
300			52.50	9.03	3.26	1.62
325				11.48		
350				14.32	3.86	1.89
375				17.70		
400				21.50	5.72	2.16
450					8.20	2.75
500					10.82	3.78
550						5.05
600						6.30

cent for pipe sizes up to 8 in., beyond which the comparison was not continued. The tables were not carried to viscosities higher than 800 Saybolt, because for greater viscosities, within the range of pipe sizes and discharge dealt with by the tables, the flow will be steady and the friction loss may be found by proportion from that at 800, varying directly as the viscosity; nor were they computed for sizes above 6 in., although it seems probable that the method gives correct results for larger diameters.

It is important to note that the fundamental proposition on which the method is based is that liquids of equal Saybolt viscosity have equal friction heads as measured in feet—not that they have equal friction pressures as measured in pounds per square inch. The first statement is true, as has been demonstrated; the second could not be, because oils of equal Saybolt viscosity may have very different specific gravities. Any attempt to compile tables in which pressure losses are shown as corresponding to given Saybolt viscosities is, therefore, basically wrong.

FLOW TABLES FOR OILS AND OTHER VISCOUS LIQUIDS

Showing Friction Loss in Pipes for Varying Saybolt Viscosities

Friction losses are given in feet of liquid per hundred feet of pipe. To convert to pounds pressure per square inch, multiply the tabular value by $0.433 \times$ specific gravity of the liquid.

The tables are computed for straight, drawn brass or steel pipe or tubing of the exact diameters indicated.

Values above the heavy line are in the region of steady flow. Values between heavy and dotted lines are in the region of uncertain flow. Values below the dotted line are in the region of eddy flow.

To adapt for calculating losses in wrought iron pipe: Above the heavy line, no correction is necessary; below the heavy line, add the following percentages to the tabular values as a roughness correction:

Pipe diameter, in.	1	2	3	4	5	6
Add, per cent.	12	9	7	5	4	3

To correct for small differences in diameter, as between the nominal and actual diameters of a pipe: Above the heavy line, friction loss for a given discharge varies inversely as the fourth power of the diameter; below the line, friction loss for a given discharge varies approximately inversely as the fifth power of the diameter.

To use the tables for viscosities greater than 800 Saybolt: Assuming the loss at 800 as a base, the increase in friction loss for a given discharge is proportional to the increase in Saybolt viscosity.

Saybolt viscosities are determined by the Saybolt Universal Viscosimeter. For greatest accuracy, the instrument should be one which has been standardized by the U. S. Bureau of Standards.

With increasing viscosity, for a given pipe and discharge, a point is regularly reached where friction loss momentarily decreases. At this point the viscosity becomes great enough to suppress the eddies in the liquid; the friction loss due to eddying being eliminated, the total friction loss is decreased. From this point on, as viscosity increases, flow is steady or non-turbulent, and friction loss increases directly as the kinematic viscosity.

To compute friction loss in drawn piping independently for a given case, proceed as follows:

Viscosity = 600 — Saybolt Universal Viscosimeter						
5	41.50					
10	83.00	5.17	1.02			
15	124.50					
20	166.00	10.34	2.04	0.65	0.27	0.13
25	207.50					
30	249.00	15.51	3.06			
35						
40		20.68	4.08	1.30	0.53	0.26
45						
50		25.85	5.10			
60		31.02	6.12	1.95	0.80	0.39
70		36.19	7.14			
80		41.36	8.16	2.60	1.07	0.52
100		51.70	10.20	3.23	1.33	0.64
125		64.62	12.75	4.04	1.66	0.80
150		77.55	15.30	4.85	2.00	0.96
175		96.00	17.85	5.66	2.33	1.12
200		144.00	20.40	6.47	2.66	1.28
225		204.00	22.95	7.28	3.00	
250		262.20	25.50	8.09	3.33	1.60
275			32.60	8.90	3.66	
300			42.40	9.71	3.99	1.92
325				10.52		
350				11.91	4.66	2.24
375				14.70		
400				17.80	5.32	2.56
450					6.82	2.89
500					9.35	3.22
550						4.28
600						5.57

Viscosity = 800 — Saybolt Universal Viscosimeter						
5	55.50					
10	111.00	6.89	1.36			
15	166.50					
20	222.00	13.78	2.72	0.86	0.36	0.17
25	277.50					
30		20.67	4.08			
35						
40		27.56	5.44	1.72	0.71	0.34
45						
50		34.45	6.80			
60		41.34	8.16	2.58	1.07	0.51
70		48.23	9.52			
80		55.12	10.88	3.44	1.42	0.68
100		68.90	13.60	4.30	1.77	0.85
125		86.12	17.00	5.37	2.21	1.06
150		103.35	20.40	6.44	2.65	1.27
175		120.56	23.80	7.51	3.09	1.48
200		137.80	27.20	8.58	3.54	1.70
225		155.00	30.60	9.65	3.98	
250			34.00	10.72	4.42	2.12
275			37.40	11.79	4.86	
300			40.80	12.86	5.31	2.55
325				13.93		
350				15.00	6.19	2.97
375				16.07		
400				17.14	7.08	3.40
450					7.96	3.82
500					8.85	4.25
550						4.69
600						5.13

and a heavy California crude oil, Nos. 11 and 12, Fig. 4, which was prepared by one of the commercial oil companies. The agreement was found to be within 10 per

1. Determine the viscosity of the liquid at the required temperature by means of a standardized Saybolt Universal Viscosimeter.

2. Convert these Saybolt seconds into the corresponding values of kinematic viscosity, $\frac{\mu}{\rho}$, by means of Fig. 2.

3. With the value of $\frac{\mu}{\rho}$ from Fig. 2, compute the value of $\frac{v \rho d}{\mu}$, where v = velocity in feet per second, d = diameter in feet.

4. With this value of $\frac{v \rho d}{\mu}$ as an argument, find the value of the friction factor, f , from Fig. 3.

5. With the value of f , from Fig. 3, compute the friction loss h , from the formula, $h = f \frac{l v^2}{d 2g}$, where h = friction head in feet, l = length of pipe in feet.

Talc in Fire-Resistant Paint*

BY RAYMOND B. LADOO†

THE increasing realization of the fire hazards involved in the use of wooden shingles caused the National Lumber Manufacturers' Association to begin five years ago a search for a suitable fire-resistant paint. The problem was submitted to the Educational Bureau of the Paint Manufacturers' Association of the United States and work was started by Henry A. Gardner at the Institute of Industrial Research, Washington, D.C., in collaboration with Dr. Herman von Schrenk, a timber expert of St. Louis.

The results of this work have been described by Heckel, in *Asbestos*,¹ who gives the following formula for one of the colors as typical:

10 60 lb. basic sulphate white lead	63.7 per cent pigment
11 00 lb. zinc oxide	
33 00 lb. asbestine (magnesium silicate)	
0 50 lb. borax	
0 90 lb. dry lamp black	
24 00 lb. linseed oil	36.3 per cent vehicle
2 00 lb. liquid drier	
10 00 lb. mineral spirits	
100.00	

It will be noted from this formula that "asbestine" forms 33 per cent of the total liquid pigment by weight or 51.8 per cent of the solid constituents. Heckel in the article referred to describes this paint as "asbestiform" and assumes that since "asbestine" is magnesium silicate it must be the chrysotile variety of asbestos. "Asbestine," however, is not asbestos, but is a trade name for a fibrous variety of talc mined in the Gouverneur district, St. Lawrence County, New York. This rather natural error persists through the article and credits asbestos with many desirable properties which are characteristic of talc.

Heckel continues:

While the tendency of paint manufacturers during the past decade has undoubtedly been to curtail the high percentages of inert pigments formerly common, there is no doubt that recognition of their technical value has led to a more intelligent and legitimate use of them in many products. This is particularly true of the asbestiform type of inert pigment, demand for which has probably multiplied within the past eight or ten years.

While there are available no statistics to corroborate this conclusion, it is nevertheless a fact familiar in the industry; a fact which is further substantiated by the common appearance of the term "asbestine" or "magnesium and aluminum silicates" on formula labels. In prepared paints of all types it appears to have won general favor; while for the other uses indicated at the beginning of this paper, other types of inert pigment appear to retain the preference.

The prevailing percentage of "asbestos" in high-grade paint formulas averages about 15 per cent, regardless of color, indicating that the pigment is introduced because of its physical qualities rather than as a diluent or cheapener.

The only practical objection I have ever heard advanced against this type of pigment was, again, due to its form. The slender fibers are said to have a tendency to "up-end" themselves, forming a minutely rough surface. I have noted this effect myself in connection with several tests, but hardly regard it as a serious practical defect.

In conclusion, an inert pigment of this type would appear to leave nothing to be desired on the score of chemical stability, while possessing, from its form, certain valuable properties belonging to it alone.

Diller² says: "Some of the large producers have one or more trade names, such as 'verdolite,' 'asbestine,' 'agalite' and 'talclay,' by which their special products are known in the market, but all these products are included under 'commercial talc.'"

TRADE NAMES CAUSE CONFUSION

From the standpoint of the talc industry as a whole it is to be regretted that such trade names should be used. Such usage causes confusion and leads to mistakes like that noted above. Talc has so many useful properties and can be utilized in so many different industries that the universal use of its proper name, talc, is strongly urged, from a business as well as a mineralogical standpoint.

Another fact brought out in Mr. Heckel's article, confirming recent experience of talc producers in New York, is that the fibrous variety of talc, contrary to popular belief, is not always most desired by paint manufacturers. It is true that in certain types of paint fibrous talc is an advantage, but in other types it has the disadvantage referred to above in addition to being too bulky for its weight. "Heavy," granular talcs are often specified by paint manufacturers as distinguished from "light," fibrous talcs. Practically all talcs are fire-resistant and it seems probable that many of the talcs on the market today could be used in this new paint.

IMPORTANCE OF THIS NEW USE OF TALC

The importance of this new use, as Heckel points out, is evident from the fact that: "The copyrighted title 'Panak' was given to the line and some fifty manufacturers were licensed to manufacture and sell it, under rigid specifications, using the association's trademark. The Lumber Association has been enthusiastic in its indorsement of this product, which will probably be pushed vigorously as soon as final decision on its classification has been made by the Underwriters Laboratory, where it is now under test."

This should afford talc producers a new market of importance, but it can be won only by removing the erroneous opinion held in some quarters in the paint industry that "asbestine" is ground asbestos. As noted in previous articles, all talcs should be tested by a uniform series of tests and the properties of talc made known to the general consuming public.

*Reports of Investigations, U. S. Bureau of Mines.

†Mineral Technologist, Bureau of Mines.

¹Heckel, G. B., "Asbestos in the Paint Industry," *Asbestos*, vol. 2, July, 1920, pp. 5-10.

²"Talc and Soapstone," Mineral Resources, 1912, U. S. Geological Survey, p. 14.

Some Remarkable Models of Atomic and Molecular Structure

BY OSCAR R. FOSTER

THE theory of the constitution of matter advanced by Dr. Irving Langmuir has attracted much attention in the scientific world.¹ For the purpose of studying these postulates Leffert Lefferts,² of Brooklyn, N. Y., has constructed some remarkable models in accordance with this electron hypothesis. They are ingeniously constructed and of great assistance in the study of the octet conception. Mr. Lefferts courteously permitted photographs to be made of the simple apparatus necessary for their production, and reproductions of models are presented herewith.

Some of the molecular models do not lend themselves readily to photographic reproduction and therefore careful inspection is essential to perceive the three dimensional relationships involved.

Briefly described, the models are plaster of paris spheres, representing electrons (and electron aggregates), which are supported by wires and geometrically arranged in accordance with Langmuir's postulates.

The technique of their preparation is extremely simple. Fig. 1 shows the essential apparatus. At A is a split mold whose central cavity is spherical; several channels radiate from this cavity whose use will be explained later. These molds are cast in type alloy around a steel ball 13 mm. ($\frac{1}{2}$ in.) in diameter; a ball-bearing was used. On the extreme right at F is shown a piece of thin sheet copper which is used for the electron supports. A strip of suitable size is cut with scissors and rolled with the fingers around a wire 1.5 mm. ($\frac{1}{16}$ in.) in diameter; a drop of solder at each end

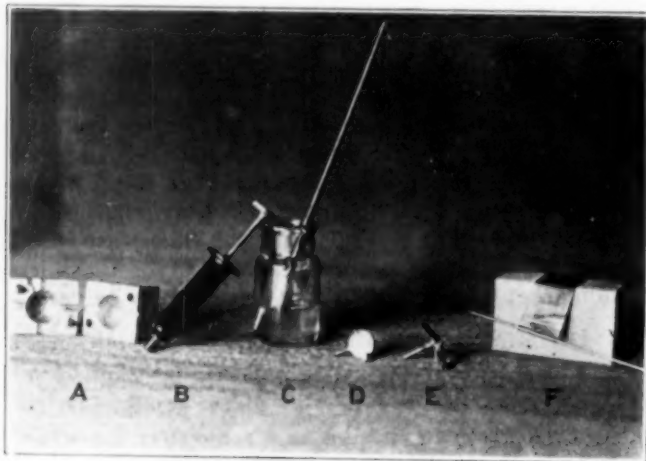


FIG. 1. ESSENTIAL PARTS OF THE APPARATUS FOR THE PREPARATION OF ATOMIC AND MOLECULAR STRUCTURE MODELS

prevents the strip from unrolling. In this way a tiny tube is formed which is pliable enough to be bent to a right angle; another short piece of tubing is soldered to this as shown at E. The short piece forms a right angle with the plane of the bent piece. When an electron model is to be made the model is coated with oil, using a camel's hair brush C (Nujol is the oil used); this oil prevents the plaster of paris from adhering to the mold. The copper tube E is placed in position in the mold, which is then closed; the channels previously

referred to serve to support the tubes and hold them firmly in position. A thin easily flowing mixture of water and plaster of paris is drawn into the syringe B, which is inserted into one of the channels and the slurry forced into the mold. In a short time the plaster of paris sets and is sufficiently hard to permit the mold to be opened. A sphere so formed is shown at D. Any slight irregularity may be corrected by cutting the plaster with a penknife. This sphere with its three projecting tubes is used to form one corner of an octet. By inserting wire of suitable length into the small tubes various combinations of electrons may be built up. Similar plaster spheres with a single straight tube are used to represent nuclei (positive electron aggregates). These are painted red so as to distinguish them from the white negative electrons. A drop of solder serves to fasten the supporting wires to the electron tubes.

A model of the helium atom is shown in Fig. 2 with a circular supporting wire; the wires are painted black. On one side of the red nucleus a flat spot is scraped, and on the white surface so exposed is placed a figure; this figure is the total number of negative electrons and therefore serves to identify the element which is represented by the model.

The structure of the neon atom is shown in Fig. 3. This illustrates, in a striking manner, the conception of the nucleus with its two attendant electrons surrounded by a complete octet. This is the stable form of electron arrangement.

A somewhat complicated model of the argon atom is shown in Fig. 4. The equatorial plane and the eight cells are represented by pieces of sheet copper. According to Dr. Langmuir the electrons situated in each cell do not trespass upon the territory of their neighbors. This atom has eighteen electrons and, since it has achieved a condition of octet completeness, is inert. A less elaborate model of this atom is shown in Fig. 5. The relative positions of the nucleus and the electrons are identical with Fig. 4.

Molecules containing more than one atom are constructed in a similar manner. Fig. 6 shows a molecule of hydrogen which consists of two nuclei holding a pair of negative electrons.

A more complex model is that of the nitrogen molecule, Fig. 7. The unique structure of this molecule is well shown. Compare this with the line drawing of the article previously referred to.³

The molecular structure of compounds is complex in greater degree. The methane molecule CH_4 has the appearance shown in Fig. 8. The arrangement of electrons in acetylene, C_2H_2 , is well illustrated in Fig. 9. The acetic acid molecule $\text{CH}_3(\text{COOH})$ has the structure of Fig. 10. This model has been called the "flying machine" molecule.

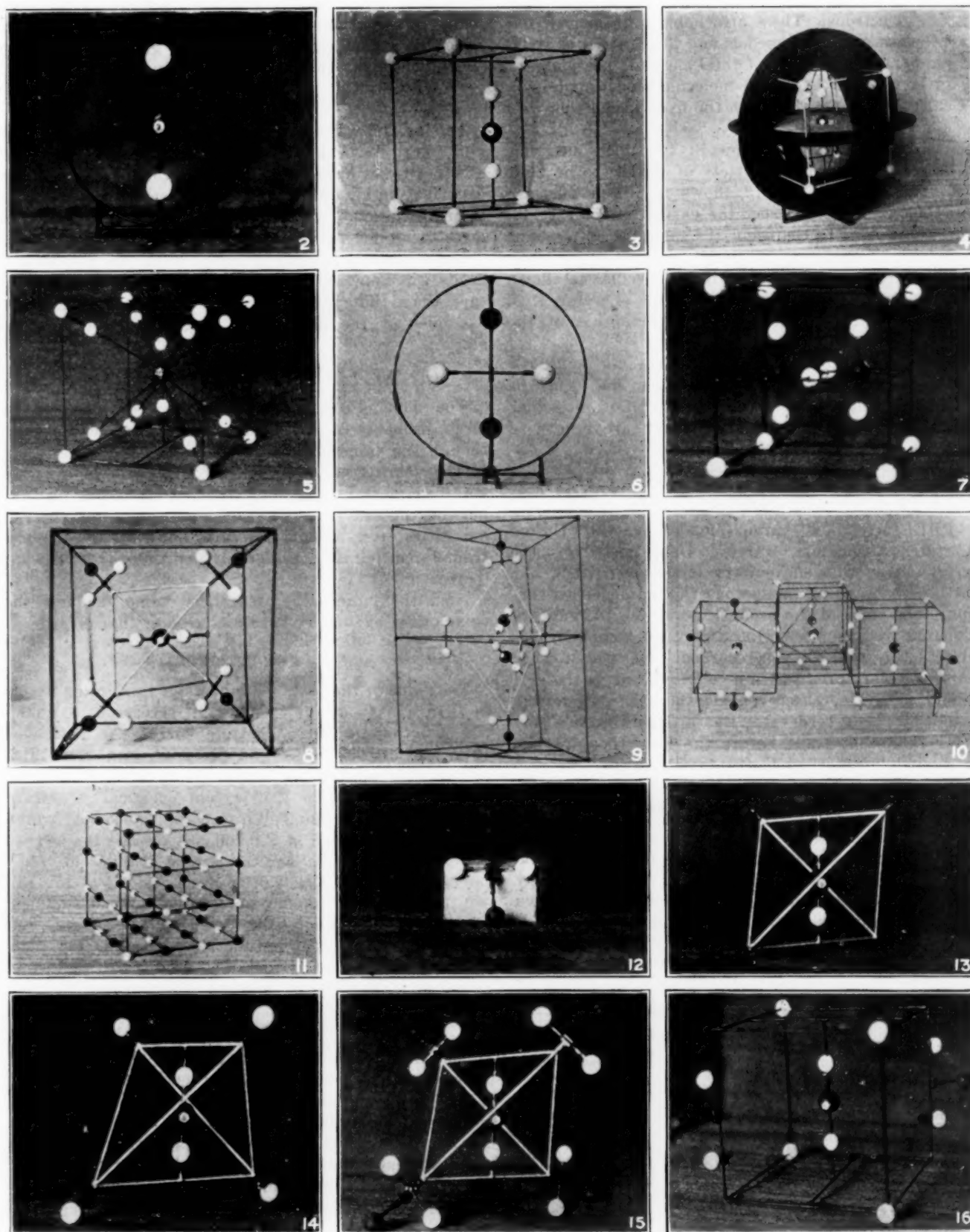
The structure called a space lattice is shown in Fig. 11. This arrangement of electrons is assumed by lithium, sodium fluoride, etc.

For ease of study of these interesting molecular structures, Mr. Lefferts has further improved his ingenious models by devising units which can be used to build molecular complexes piecemeal. These I shall call "synthetic models." Plaster of paris spheres are cast as above described and to these are soldered short wires; on the free end of this wire is clinched and soldered small spring paper clips. Some of these

¹See CHEM. & MET. ENG., vol. 21, No. 2 (July 15, 1919), for a brief summary of Langmuir's postulates.

²Formerly consulting chemist, New York City.

³CHEM. & MET. ENG., vol. 21, No. 2, Fig. 4.



FIGS. 2 TO 16. MODELS OF ATOMIC AND MOLECULAR STRUCTURE

Fig. 2. Helium atom.
 Fig. 3. Neon atom.
 Fig. 4. Argon atom.
 Fig. 5. Argon atom, same as Fig. 4,
 but stripped of reference planes.
 Fig. 6. Hydrogen molecule.
 Fig. 7. Nitrogen molecule.
 Fig. 8. Methane molecule.

Fig. 9. Acetylene molecule.
 Fig. 10. Acetic acid molecule.
 Fig. 11. Arrangement of electrons,
 which is assumed by lithium, sodium
 fluoride, etc.
 Fig. 12. Hydrogen molecule model
 made synthetically (compare with Fig.
 6).

Fig. 13. Synthetic model of a carbon
 nucleus.
 Fig. 14. Synthetic model of a carbon
 atom.
 Fig. 15. Synthetic model of a methane
 molecule.
 Fig. 16. Synthetic model of a water
 (H_2O) molecule.

attachable spheres are painted red to represent positive (+) nuclei and others are left white to represent negative (—) electrons. These attachable units permit one to synthesize molecular models and illustrate in a striking manner the flexibility of the Langmuir postulates.

Fig. 12 shows a hydrogen molecule model made synthetically. Compare this with the fixed-model shown in Fig. 6.

Suitable supporting framework to which electrons can be attached permit a variety of models to be built from one nucleus. Fig. 13 shows a carbon nucleus; from this we may construct the carbon atom, Fig. 14, or it can be used to represent the molecule of methane CH_4 as in Fig. 15.

Another framework for building molecules is shown in Fig. 16 arranged to show the molecule of water, H_2O . Here is shown even electronic distortion from the strictly cubical octet form.

By these ingenious models, especially the synthetic models, Mr. Lefferts has greatly aided the study of Langmuir's postulates. A great variety of molecular aggregates can be put together which are otherwise somewhat difficult to visualize.

The Pottery Industry in 1919

A PRELIMINARY survey made by the United States Geological Survey, Department of the Interior, shows that the pottery industry in 1919, like many others, was in a prosperous though unsettled condition. The value of the product, according to Jefferson Middleton, by whom the statistics were compiled, was doubtless the greatest yet recorded. No statistics of quantity of ware produced are collected, but as the cost of manufacture increased considerably, the output represented by this record value was probably little if any greater than that made before the war, though some plants at times reached their utmost capacity of production.

THE POTTER'S HANDICAPS

The year opened with unequalled prospects, most of the plants were kept going to the limit of the labor and material available, and at the end of the year many orders remained unfilled. The usual summer shutdown was confined to three days in July, including July 4. Labor troubles were limited to a few minor strikes, most of which were unauthorized by the unions. The principal handicaps to the industry were shortages of

labor, materials and fuels. The railroad embargoes were also embarrassing, and some potters in the Ohio Valley resorted to shipments by water. The coal strike was also a handicap, though not so great a one in the West, where natural gas is the principal fuel.

BETTER WARE NOW MADE

During the war the demand for pottery was so great and was so inadequately supplied that ware which would at other times have been rated as seconds or thirds was eagerly bought, but in 1919 an endeavor was made to improve the quality of the ware, especially in order to meet inevitable foreign competition.

Some years ago experimental work on bisque doll heads was done and a plant was equipped to manufacture them, but few were sold until 1919, when fine examples of the doll-makers' craft were put on the market.

IMPORTS AND EXPORTS

The demand for domestic pottery continued to be large, probably in part because the imports were small, though the value of imports in 1919 was greater than in the years from 1915 to 1918. Before the war we obtained most of our imported pottery from Europe, but during the war we imported increasingly large quantities from Japan. In 1919, however, the imports from Japan fell off considerably and those from Europe increased.

Notwithstanding the enormous home demand the value of the exports in 1919 was greater than in 1918.

PRODUCTION

The value of the pottery products of the United States in 1919 was about \$76,140,000, an increase of \$12,228,000 over that in 1918. The total increase in 1919 over 1917 was \$19,997,000, or 36 per cent, and over 1913, \$38,148,000, or 100 per cent. Every kind of pottery increased in value in 1919 except chemical stoneware and chemical porcelain. White ware (household wares except china), valued at \$29,700,000, showed the largest increase, \$4,394,000; sanitary ware, valued at \$14,480,000, increased \$3,239,000; china, valued at \$7,625,000, increased \$1,318,000; porcelain electrical supplies, valued at \$12,190,000, increased \$995,000; and red earthenware, whose output in 1918 was affected indirectly by curtailment of fuel, recovered in 1919 and was valued at \$1,160,000, an increase of \$253,000.

WHITE WARE AND CHINA

The value of white ware and china, which comprise the general household wares and constituted 49 per cent of all pottery products in 1919, was \$37,325,000, an increase of \$5,712,000, or 18 per cent over 1918. If to this sum is added the value of sanitary ware and porcelain electrical supplies, which formed 84 per cent of the output in 1919, the total value was \$63,995,000, or \$9,947,000 more than in 1918.

CHEMICAL STONEWARE

The production of chemical stoneware, which was used largely in the manufacture of munitions in 1918, naturally fell off with the cessation of hostilities, so that the production in 1919 was valued at \$645,000, a decrease of \$903,000. The decrease in chemical porcelain, valued at \$180,000, was \$42,000, and may possibly be ascribed to the same cause.

VALUE OF POTTERY PRODUCTS IN 1918 AND 1919

	1918	1919 (Estimated)		Approximate or Decrease in 1919 Amount	Increase or Decrease in 1919 Per Cent
Red earthenware.....	\$906,861	\$1,160,000	+	\$253,000	+28
Red and brown white- lined cooking ware.....	425,822	490,000	+	64,000	+15
Stoneware.....	4,454,164	4,860,000	+	406,000	+9
Chemical stoneware.....	1,547,779	645,000	—	903,000	—58
Chemical porcelain.....	221,931	180,000	—	42,000	—19
White ware.....	25,305,926	29,700,000	+	4,394,000	+17
China.....	6,307,349	7,625,000	+	1,318,000	+21
Sanitary ware.....	11,241,138	14,480,000	+	3,239,000	+29
Porcelain electrical sup- plies.....	11,194,812	12,190,000	+	995,000	+9
Miscellaneous.....	a 2,306,011	b 4,810,000	+	2,504,000	+108
	\$63,911,793	\$76,140,000	+	\$12,228,000	+19

(a) Including aquarium ornaments, art pottery, chimney tubes, cracque porcelain, filter stones, gas and electric lighting and heating appliances, garden furniture, Guernsey and Oxford ware, Indian, Nilok, Omar Khayyam, Pewabic, and Rookwood pottery, pins, stilt and spurs for potters' use, porcelain door knobs and filter tubes, porcelain hardware supplies, porcelain guides for use on textile machinery, saggars, shuttle eyes and thread guides, tobacco pipes, toy marbles, turpentine cups, umbrella stands and vases.

(b) Including art pottery, cracque porcelain, doll heads, gas-burner tips, gas mantle rings, hardware trimmings, heating porcelain, nursery ware, pins, stilt and spurs for potters' use, porcelain thread guides, radiants, saggars, smoking pipes, soda-fountain supplies and turpentine cups.

Meeting of Fertilizer Division, A.C.S., at Chicago

THE meeting of the Fertilizer Division of the American Chemical Society at the society's sixtieth gathering in Chicago, Sept. 6 to 10, 1920, was extremely interesting. A brief synopsis of some of the more important papers presented follows.

CYANAMIDE LOSES VALUE IN FERTILIZERS

"The Changes Taking Place in Cyanamide When Used in Mixed Fertilizers," by ROLLA N. HARGER, was a paper perhaps of greatest industrial significance in the Fertilizer Division meetings. This report was presented by Dr. OSWALD SCHREINER, under whose general direction the work had been done. Mr. HARGER has demonstrated that cyanamide in fertilizer changes within short periods almost completely into dicyanodiamide, in which form it is, of course, wholly unavailable as plant food. In certain tests 60 per cent was converted thus within twenty-four hours and practically all had gone over into the complex within ten days.

It is concluded that this conversion is caused principally by acid phosphate in the presence of moisture. Previously the presence of cyanamide in mixed fertilizers has been believed to be objectionable in large quantities because of reversion of the phosphate, but the effect of the phosphate upon the cyanamide, making it also unavailable, has apparently never before been described. Tests were also reported on the conversion to the complex form simply by moisture in the presence of quartz and it was found that a similar effect is noted under these circumstances. However, the rate of conversion is much slower, though still rapid enough to represent serious loss to the plant-feeding value in very short periods. In this connection it was particularly pointed out that although the nitrogen is no longer available as plant food it still does appear in the Kjeldahl determination.

Dr. SCHREINER in commenting upon the results implied that only the European method of broadcast distribution of cyanamide unmixed with other fertilizer materials could probably be considered as worth while. It was pointed out, however, that this method of distribution is not looked upon favorably by the agricultural interests of this country and considerable difficulty in use of this material as a fertilizer was to be expected if this method of distribution was essential. It was also suggested in connection with this paper that dicyanodiamide is perhaps the cause of poison which has been charged to cyanamide; the latter is apparently much less poisonous but readily polymerizes to the more poisonous form as indicated above.

Another paper by Mr. HARGER described a quick, reliable method for determination of dicyanodiamide in the presence of cyanamide and urea. This method depends upon the precipitation in the form of a double salt by means of silver picrate.

FERTILIZER LEGISLATION

E. G. PROULX, Indiana State Chemist, reported on fertilizer analyses made in connection with the enforcement of state regulations. He pointed out the large excess of actual fertilizer value above the guaranteed analysis required on the labels of fertilizer materials. It was pointed out that the value of a chemist to his employer under these circumstances depended largely

upon the accuracy with which he enabled plant control to be maintained. During the first year under the present Indiana law only 8 per cent of the samples of fertilizer tested were up to their guarantee in every particular. Now a very large majority of the samples, in general 90 per cent, comply in every particular with the guarantee labels. However, on about \$6,000,000 in fertilizer value, computed at the market price of fertilizer constituents, one year's results showed an overage of \$400,000. This, in the opinion of Mr. PROULX, is much more than necessary. Reliable laboratory work should give compliance with guarantee without nearly as great overage as is found in many factories. Selection of high-grade chemists and use of reliable methods in the laboratory were two means of remedy suggested.

Mr. PROULX defined a "perfect" fertilizer law as one which would provide for inspection and afford sufficient inducement to honest fertilizer manufacturers that they would each year make better fertilizer than formerly. The tendency of co-operative purchasing of fertilizers was emphasized as making very necessary a more intelligent handling of the fertilizer trade upon the basis of cost per unit of plant food. In this connection it was suggested that the dry fertilizer mixer as far as possible should stay out of the ammoniate market, leaving these ammoniates to the wet mixer, who could then obtain them at their relative plant food value, instead of as now at two or more times this value.

The report of the fertilizer legislation committee, J. E. BRECKENRIDGE, chairman, was also presented at these sessions. Some of the recent legislation and the trend of regulations were set forth.

BORON AND BORAX EFFECTS

J. E. BRECKENRIDGE discussed "Boron With Relation to the Fertilizer Industry." After discussing the unfavorable influence of borax and the improvement of laboratory methods for determining different constituents, he concluded that the real problems in connection with boron in fertilizers were practically a thing of the past. Hereafter it is simply a problem of regular vigilance in determining percentages and preventing excessive amounts. F. B. CARPENTER discussed the new series of results which he had obtained in field tests of borax on cotton, corn, potatoes, tobacco and sweet potatoes. His results confirm the general experience that weather and soil conditions are of very great importance, as rapid elimination of borax from the soil follows when the weather is favorable; but amounts of 16 lb. or more per acre are believed to be decidedly serious.

ANALYTICAL METHODS

The Committee on Sampling, F. S. LODGE, chairman, reported at this meeting on sampling methods. In this connection Mr. PROULX' remarks regarding sampling methods used in Indiana are significant. Five-pound samples rather than two-pound were urged as essential if reasonable agreement between plant and inspection laboratories is expected.

F. B. CARPENTER discussed the determination of nitrogen in fertilizers containing both organic and nitric nitrogen. He pointed out that it is necessary to complete the solution of salts present before beginning the strong heating of the solution for the Kjeldahl digestion. Variation of the nitrogen determination from 3.7 to 4.95 per cent, simply as a result of different laboratory practice in this particular, was indicated. A more ac-

curate definition of the method by the Association of Agricultural Chemists was urged as an important essential.

R. D. CALDWELL and H. C. MOORE reported on the influence of different strengths of alcohol upon the potassium determination. If sodium salts are present, it was suggested that concentrated alcohol, 92 or 95 per cent, must first be used or low results for potassium are likely. Here again change in the "official" methods were urged.

The importance of the "blank" in the Kjeldahl process was indicated in the article by B. F. ROBERTSON. He suggested a limit of 0.3 per cent upon the blank. Opinion of others present indicated that this was an unnecessarily high allowance.

POTASH

S. W. PARR reported on the potash shales of Illinois, briefly pointing out the availability of several shales having 5 per cent or more K_2O . At least one of these is recommended as suitable for cement manufacture, affording, if properly worked, a possible recovery of 5.3 lb. of potash per bbl. of cement, which is equivalent to 70c. or 80c. per bbl. for this byproduct. The two classes of shales were discussed briefly, pointing out the fact that the feldspathic group is not readily usable in this connection.

H. A. HUSTON reported his experiences recently in Germany, where he has been investigating the potash industry. This industry has been almost completely socialized, and a very complicated organization has been developed as a consequence. Labor is plentiful but very high. The limiting feature seems to be transportation, which is not only expensive but difficult to obtain at any price. Contrary to general report, Mr. HUSTON found that there were no stocks available at the end of 1918 or now. Those stocks which were first reserved by the inter-allied agents for the United States to purchase were later sold elsewhere upon these allied agents being advised that the stocks were not needed in the United States. As a consequence when American purchasers undertook to secure material, prices were much higher; and the charge of discrimination against the United States naturally followed. Mr. HUSTON is convinced that there has been no discrimination against this country in any case of purchases made at the same time that other countries made them.

The fuel situation is one of the controlling elements in the matter more recently, as cost of coal is very high and it is difficult to procure in adequate amounts. The military activity of the Poles and the Reds cutting off the Silesian coal supplies has been a particularly serious factor to this end. Incidentally Mr. HUSTON reported that ammonium sulphate supplies are also very short in Germany, largely as a result of the fuel shortages. It is his belief that at the present time there are 190 potash-producing shafts operated.

RELATION OF FERTILIZER INDUSTRY AND CHEMISTRY

C. H. MACDOWELL discussed the general subject of the relationships of chemistry and the fertilizer industry. He pointed out that chemistry had a long stern chase in overtaking fertilizer activities, and only recently had attained distinct success and recognition. The use of chemical control to eliminate hidden wastes was, in his opinion, now recognized as essential to industrial success. The production of byproducts of the

fertilizer industry was pointed out as only now beginning. The preparation of sodium fluosilicate and magnesium fluosilicate are two striking examples. The fluorine volatilized from fertilizer materials has thus been made available in marketable products, which at first found limited use as insect powders but have since developed important applications for waterproofing of concrete and other purposes.

The inter-relation of fertilizer and war industries was emphasized. In fact it was pointed out that plants and cannon eat much the same foods. Nitrogen fixation, sulphuric acid manufacture and other important elements in fertilizer activity contribute equally to military preparedness, as a consequence.

Canada's Baking-Powder and Flavoring Industry

A preliminary report on Canada's baking-powder and flavoring-extract industry for the calendar year 1918 has been completed by the Dominion Bureau of Statistics, covering the operations of twenty-four establishments, of which eleven were in the Province of Quebec, ten in Ontario, two in Nova Scotia and one in Manitoba.

The total capital invested in the industry for the whole of Canada was \$2,259,753, of which the principal items were: Land, buildings and fixtures, \$561,493; machinery and tools, \$209,374; materials on hand, stocks in process, finished products, fuel, and miscellaneous supplies, \$816,341; and cash, trading and operating accounts, and bills receivable, \$672,545. Distributed by provinces, Ontario shows a total investment of \$1,725,424; Quebec, \$347,170; and Nova Scotia and Manitoba combined, \$187,159.

The quantity and cost value delivered at the works of all materials used during the year are itemized in the accompanying table:

Classes of Materials	Quantity	Cost Value at Factory
Coffee beans, green, lb.	926,712	\$185,693
Spice materials, lb.	103,734	27,713
Baking-powder materials:		
Soda bicarbonate, lb.	1,105,461	23,131
Sulphate of ammonia, lb.	28,590	1,304
Cream of tartar crystals, lb.	8,768	6,710
Other materials, not specified		232,272
Cocoa beans, lb.	8,000	1,760
Essential oils, lb.	21,667	76,547
Alcohol, gal.	21,179	92,602
Sugar, lb.	1,406,767	124,477
Starch and glucose, lb.	364,290	22,973
Flour, bbl.	712	7,927
Phosphates, lb.	70,568	12,037
Oranges		17,965
Fruits, qt.	154,563	29,030
All other materials		938,640
Total cost		\$1,800,801

The quantity and selling value at the factory of the various products made during the year are itemized in the table below:

Classes of Products	Quantity	Selling Value at Factory
Baking powder, lb.	4,235,001	\$942,874
Coffee, lb.	932,457	199,852
Spices, lb.	95,927	41,240
Cocoa and chocolate, lb.	8,000	2,160
Flavoring extracts and essences, doz.	204,692	310,242
Jelly powders, cases	17,965	82,256
Yeast cakes, cases	332,333	430,270
Lye, cases	27,915	180,513
Pickles, gal.	33,548	71,022
Fruit oils, gal.	8,955	33,731
Caustic soda, lb.	488,025	38,007
All other products		821,539
Total		\$3,153,706

The twenty-four establishments covered by this review employed 289 male and 300 female workers, to whom they paid \$508,672 in salaries and wages during the year.

Status of Manufactured Fuel Gas

SAMUEL S. WYER has just reported on the gas situation in the natural gas properties of the Philadelphia Co., which supplies Pittsburgh and a considerable area south and west of that city. Mr. Wyer points

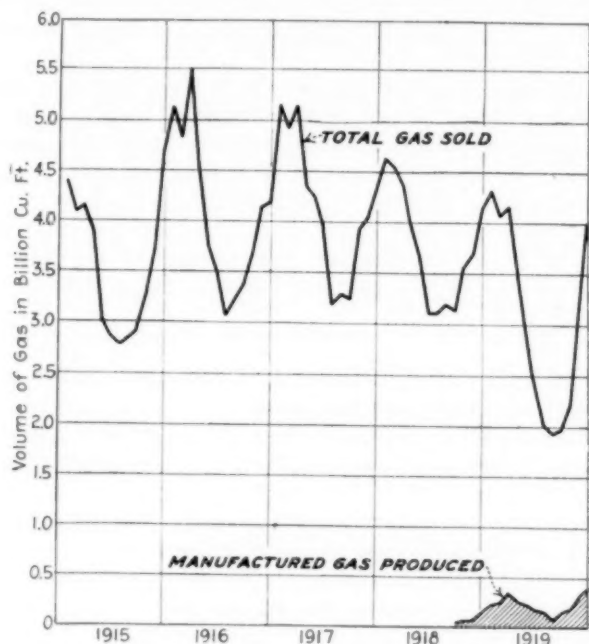


FIG. 1. MONTHLY VOLUME NATURAL AND MANUFACTURED GAS SOLD BY THE PHILADELPHIA CO. IN THE PITTSBURGH DISTRICT

The volume of manufactured gas shown here is the actual volume delivered into the natural gas mains. As the heating value of this was so low that 11 cu. ft. of this manufactured gas is required to equal 1 cu. ft. of natural gas, the natural gas equivalent of the manufactured gas produced is so small that it would be impossible to show on this chart.

out that conservation methods in the use of natural gas can materially reduce the demand at all seasons of the year, thereby making more nearly adequate the limited supplies available. The present situation of this company, which probably is typical of a number of the concerns whose supplies in the field are failing, is graphically set forth in Fig. 1. This chart shows the relatively small proportion of output of manufactured gas which has been produced. Fig. 2 shows the estimated effect of conservation by proper methods of use of

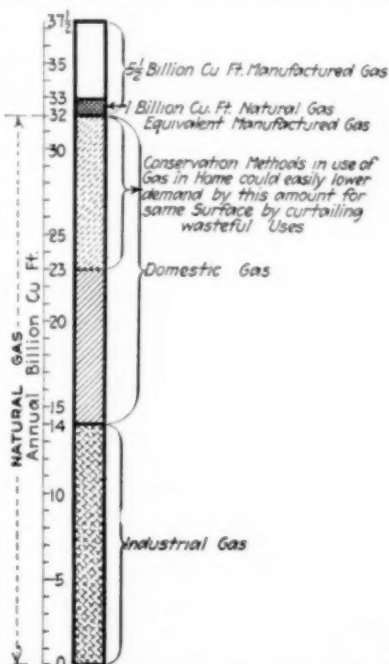


FIG. 2. RELATIVE VOLUME NATURAL AND MANUFACTURED GAS FOR THE PHILADELPHIA CO.

Spending \$2,000,000 on a mixed producer and water gas plant would make 5 billion cu. ft. of manufactured gas that would have a natural gas equivalent of one billion cu. ft. Note that this natural gas equivalent requiring \$2,000,000 capital input is only one-ninth the saving that could be effected by using conservation methods in gas use.

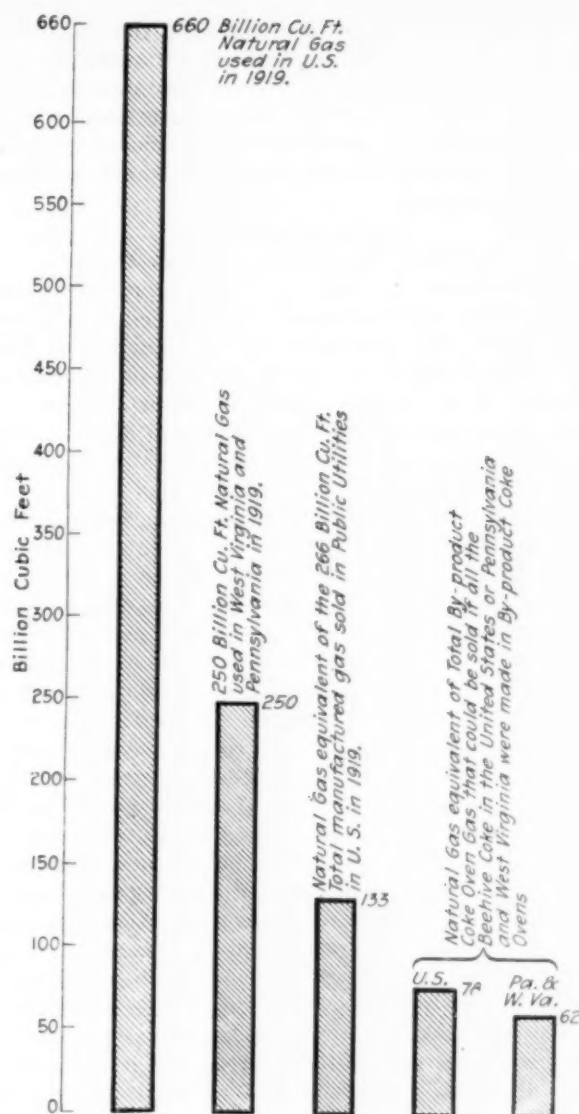


FIG. 3. STUDY IN GAS VOLUME PERSPECTIVE

The 250 billion cu. ft. of natural gas used in West Virginia and Pennsylvania represents 37.8 per cent of the 660 billion cu. ft. used in the entire United States. The natural gas equivalent of the entire manufactured gas industry in the United States, or 133 billion cu. ft., represents 20 per cent of the total natural gas industry. The natural gas equivalent of the total amount of by-product coke-oven gas that could be made in Pennsylvania, or 62 billion cu. ft., represents 25 per cent of the 250 billion cu. ft. of natural gas used in Pennsylvania and West Virginia.

gas in the home,¹ the reduction in demand being estimated at 9,000,000,000 cu. ft. per year, or approximately nine times the quantity of manufactured gas now produced to supplement the natural gas supply. These same relationships are still more significantly shown in Fig. 3, which indicates:

1. The volume of natural gas sold in the United States in 1919, 660,000,000,000 cu. ft.
2. The natural gas used in West Virginia and Pennsylvania, 250,000,000,000 cu. ft.
3. The natural gas equivalent (computed on an equal B.t.u. basis) of the total manufactured gas sold by public utilities in 1919, 133,000,000,000 cu. ft.
4. The natural gas equivalent of the byproduct coke-oven gas that could have been sold if all the beehive coke had been made in byproduct ovens: (a) in the United States, 78,000,000,000 cu. ft., and (b) in Pennsylvania and West Virginia only, 62,000,000,000 cu. ft.

It is evident from this last chart that the coking of coal on the present scale is not nearly adequate to pro-

vide gaseous fuel as a substitute for the natural gas supplies which are now available but rapidly diminishing in volume. Over eight times the amount of coal now coked in beehive ovens would have to be coked in byproduct ovens, in addition to that now so treated, to supply the deficiency if the natural gas supply were completely interrupted.

Artificial Wool From Cotton Waste

Announcement has been made that a process has been discovered by which artificial wool can be produced from cotton waste, says the *South African Journal of Industries*. The basis of the artificial wool is cellulose acetate, and it is claimed that the material is an even better insulator against heat and cold than ordinary wool, that it will wear well and that it can be successfully dyed any desired color.

The new material has, it is understood, been subjected to severe tests by the textile department of the Leeds (England) University, where it has been successfully converted into fabrics. Cloth was woven with a mixture consisting half of artificial wool and half of natural wool, the product resembling tweed. The cloth, according to Prof. A. F. Barker, head of the department concerned, would prove serviceable for men's wear or for wear by women who fancy cloth resembling homespun.

Prof. Barker declares that artificial wool will have results corresponding to those of artificial silk, but pure wool will not be ousted from the market any more than pure silk has been. It cannot be assumed that people will prefer fabrics of artificial wool to those of natural wool. The artificial wool, however, should be much cheaper than natural wool, and it may be found to have wearing qualities which will commend it to the workers. The *Overseas Daily Mail* states that it is recognized that the new product has certain limitations, one of which is its liability to break and its inelasticity. Owing to this it may not at present be possible satisfactorily to use it in the production of yarns on the worsted principle, for which purpose it is necessary for yarn to possess a uniform combing length of 2 in. or more. Where short fibers can be employed, however, such as in woolen yarn and cloth manufacture, it may prove serviceable.

Status of Belgium's Artificial Silk Industry

In a report of the development of the artificial silk industry in Belgium, Geoffroy Langlois, agent general of the Province of Quebec, writing from Paris, brings out many items of interesting information.

Before the war Belgium was the producer of one-quarter of the world's production of this important material. The four principal concerns, located in Tubise, Oburg, Maransart and Alost, employed about 6,000 hands. These companies were closed down during the war and also suffered severe material losses as a result of the German occupation. It was not until July, 1919, that the first of these concerns resumed operations, followed by the others later. In March, 1920, about 90 per cent of the pre-war number of hands was employed, working under an 8-hr. day contract.

In spite of these conditions, one concern has been able to increase its daily output one-third, and prospects for the industry for the future look bright. Prices at the present time are very near ten times what they were in 1914. One kilogram of artificial silk is worth now, best quality, from 130 to 140 f., and second quality, 105 to 125 f.

Historical Notes on Tungsten Refining in Europe*

BY CAMILLE MATIGNON

FERROTUNGSTEN and powdered tungsten are derived from the various tungsten minerals. In the latter case, an intermediate product, tungstic acid, is first obtained.

Alloys of iron and tungsten have been made for quite a long time by direct combination of the two metals. Berthier, in this way, obtained ferrotungsten containing 40, 50 and 80 per cent of W as early as 1845. Before the advent of the electric furnace, the alloys were prepared by the reduction of wolframite in crucibles, heated in a recuperative gas furnace. The electric furnace has supplanted gas furnaces completely.

PROCESS OF MANUFACTURE OF FERROTUNGSTEN

The works of Paul Girod at Ugine have paid special attention to the manufacture of these alloys, which are also produced in the Giffre plant at Saint Beron and at Liver, in the Keller Leleux factory. The concentrated mineral is reduced directly in the electric furnace, after the proper fluxes have been added, so as to remove the bases which accompany the iron in the form of a fusible slag. This operation does not result in a complete purification of the alloy, as the greater part of the impurities existing in the original mineral are still to be found in the product.

It is, consequently, necessary to start with a pure mineral free from S, P and As particularly. When this is done, a metal is obtained which is strongly contaminated with carbon. To remove the latter, the metal is subjected to a refining process, by heating it in contact with tungstic acid, which reduces the carbon in the alloy.

For example, the mineral containing 69.2 per cent WO₃, 17.5 per cent FeO, 3.6 per cent MnO and 2.2 per cent SiO₂, gave an alloy of the following composition in the electric furnace: W 50.99 per cent, C 0.43, Fe 11.4, Mn 6.84, Si 0.84 and P 0.014. The reduction was accomplished by treating 100 kg. of the mineral with 250 kg. of anthracite coal (10 per cent ash).

The electrometallurgical works of Paul Girod manufacture three types of ferrotungstens. The compositions of these alloys are as follows:

	I	II	III
W.....	64.7	80.0	87.4
C.....	1.56	1.5	0.38
Mn.....	0.43	1.5	0.38
Al.....	0.09	1.5	0.38
Si.....	0.33	1.5	0.13
Sn.....	Trace	1.5	0.13
S.....	0.01	1.5	0.007
P.....	0.007	1.5	0.009

The 65 per cent W alloy is suitable for use in the open-hearth furnace, as it is very fusible and is more easily incorporated in the charge. To prepare the alloy, very pure concentrates are used.

The standard method of producing powdered tungsten was first described by Berzelius and later patented by Oxland. It is the well-known carbonate process, whereby a tungstate is obtained which is afterward converted into the acid by means of HCl. The pure metal is obtained by the reduction of the acid H₂WO₄.

Carbon is generally used as the reducing agent. Zinc has also been used in Germany and Australia. Hydro-

*Abstracted and translated from *Chimie et Industrie*, vol. 3, pp. 277-292, 422-434.

gen and water gas have also been recommended for this purpose, but the operation is a slow one and demands a high temperature, somewhat around 1,100 deg. C.

TUNGSTIC ACID

Tungstic acid, made from sodium tungstate, is always contaminated with the latter salt, and when the acid is reduced to the metal itself, the latter always contains a sodium product, forming what is known as tungsten bronzes— $\text{WO}_3\text{Na}_2(\text{WO}_3)_n$. Before the war most of the tungsten made in Germany was only 96 to 97 per cent pure, the difference consisting mainly of tungsten bronzes. An entirely new method has been developed in France which permits the production of pure tungsten.

This process is used in the Gaillonnet factory, near Meulan. Instead of decomposing the tungsten mineral (wolframite) with soda ash, an acid is used. In analyzing wolframite in the laboratory, use had been made for a long time of an acid mixture (HNO_3 and HCl) to dissolve the mineral, but the action is too slow to be employed on a plant scale. Consequently, instead of aqua regia, moderately strong H_2SO_4 was employed. The boiling point of the acid should be sufficiently greater than 100 deg. C. and its solvent properties strong enough to dissolve the iron and manganese sulphates which are formed, as in the following reaction:



The use of an oxidizing agent, such as HNO_3 , results in the transformation of the ferrous sulphate into the ferric sulphate.

The tungstic acid obtained in this way can be pure only if the decomposition of the mineral is complete and if the silica and the SnO_2 have been eliminated in the form of insoluble precipitates. Phosphorus and arsenic, whose acids, as is known, have a tendency to unite with tungstic acid, should not be present, for if they are they would follow along with the tungstic acid, at least in part, and would be found in the final metal.

PRACTICE AT GAILLONNET

At Gaillonnet it is the practice to purify the mineral itself rather than the tungstic acid. The sulphur, phosphorus and arsenic are removed by one or more roasting operations, and the SiO_2 and SnO_2 by a new electromagnetic treatment. By means of an apparatus having three and four poles, especially adapted for the mineral, the wolframite can be obtained with an astonishing degree of purity. This latter gives a very pure tungstic acid.

The wolframite that is treated in this factory comes from Bolivia and contains 68 to 70 per cent tungstic acid. It is received in sacks, each holding 50 kg., and is found in rather regular pieces from 0.5 cm. to 1.5 cm. in size, in which the wolframite and the quartz are not intimately mixed. It is first broken up in a toothed crusher (Shoes system) so that the greater part can pass through a 130-mesh screen. The material is then passed thrice through a four-pole electromagnetic separator. The tungstates of Fe and Mn are thereby freed from all gangue materials.

ANALYSES OF BOLIVIAN ORES

The analyses of three typical Bolivian ores found in the market are given in Table I.

Lot B, which contains a considerable quantity of

cassiterite and quite some quartz, after crushing and magnetic separation, showed a content of 0.08 per cent SnO_2 and 0.12 per cent SiO_2 . The tungsten loss in the waste does not exceed 3 to 4 per cent. The mineral must be almost always roasted, to remove P, S and As.

TABLE I. ANALYSES OF THREE TYPICAL BOLIVIAN ORES

	A	B	C
WO_3	61.73	60.92	69.87
SnO_2	1.28	11.78	0.45
SiO_2	1.05	2.50	0.64
Fe.....	24.38	12.47	23.92
MnO.....	10.43	10.23	1.60
CaO.....	0.92	1.80	2.08
MgO.....	Trace	0.36	0.25
S.....		Trace	0.70
P.....	0.01	0.02	0.02
As.....	0.04		0.43
Cu.....	0.15	Trace	

This operation may be performed at times before or after roasting, and at other times before or after separation, as it helps the magnetic action of the separator. The plant possesses two crushers, each of which can treat 1,500 to 2,000 kg. of mineral per hr., as well as two separators.

CHEMICAL TREATMENT

The chemical treatment consists in decomposing the mineral with H_2SO_4 , whereby the Fe and Mn pass into solution, while the tungstic acid remains undissolved. The process is carried out in a conical-shaped vessel, lined with lead, in the interior of which a jet of steam is introduced. The steam serves the double purpose of maintaining the acid at the boiling point and of constantly agitating the mineral in the bath.

After the action has ceased, the liquor is drawn off and transferred into a settling tank, where the tungstic acid is permitted to settle out. The sulphuric solution is decanted and the tungstic acid is then subjected to systematic washing with hot water. As the washing approaches an end, the wash waters are acidulated to prevent the formation of colloidal tungstic acid. The sulphuric liquors are treated to recover the MnSO_4 and $\text{Fe}_2(\text{SO}_4)_3$ (FeSO_4 has been oxidized in the course of the operation) and the remaining acid is worked over again.

In principle, the isolation of tungstic acid appears simple enough, and in reality it requires only a comparatively short time to accomplish it. The residual acid wash waters flow into a draining well, which is filled with lime, and from there are dumped into the river.

The wet tungstic hydrate is first centrifuged and then transferred to the desiccation and calcination apparatuses. The desiccation, which must be carried to 900 deg. to obtain the anhydride WO_3 , is carried out in a revolving furnace, heated with fuel oil. The composition of the material, as it comes out of the apparatus, is shown in Table II. The loss in the operation amounted to 10.03 per cent.

TABLE II. COMPOSITION OF CALCINED TUNGSTIC ACID

	Per Cent
WO_3	99.84
FeO.....	0.09
SiO_2	0.05
SnO_2	Trace
MnO.....	
CaO.....	
MgO.....	
As.....	
P.....	
S.....	Trace

To obtain the metallic powder, the anhydride (WO_3)

is reduced by means of carbon. This is quite a delicate operation, as, contrary to what takes place in the greater part of metallurgical operations, the reduction is performed by the carbon itself and not by its lower oxide (CO). Therefore, it is very necessary that the mixture of the carbon and the oxide should be as homogeneous as possible, so that each particle of the oxide is entirely surrounded by the reducing agent. A carbonaceous material which is as pure as possible is used—that is, wood charcoal—so as to prevent contamination of the metal. The reduction takes place at a high temperature, but this should be below the formation point of the tungsten carbides. The reaction is as follows:



The excess of carbon is separated from the metal by lixiviation. The great density of the tungsten and the small density of the carbon render this a very easy operation.

FUEL OIL-FIRED REDUCTION FURNACE

The WO_3 , as it comes from the calcining furnaces, is often agglomerates in rather large pieces. This mass is finely pulverized and mixed with purified wood charcoal in equal parts. Then the whole mixture is worked up in a ball mill so as to obtain the intimate contact of the two materials necessary for the success of the operation. The reduction is carried out in graphite crucibles, lined with a refractory oxide, irreducible by the charcoal. These crucibles contain 50 kilos of WO_3 . They are heated in specially made furnaces, fired with fuel oil, which makes possible the rapid attainment of high temperatures. The crucibles are placed in the center of the furnace and all about them the flame, produced by a jet of atomized oil, mixed with a current of air from a blower, whirls with a helicoidal motion. Temperatures of 1,500 to 1,800 deg. C. are easily obtained in this way. The operation lasts two hours.

During the cooling process it is important to avoid reoxidation of the metal. As soon as reduction is complete, the crucible, which at all times is fitted with a well-adjusted cover, is drawn out of the furnace and placed in a small cylindrical chamber, where it is covered over with charcoal. The cooling takes 48 hr. under these conditions. The mass, which has agglomerated to some extent, is pulverized again and then washed to remove the carbon. When this operation is properly carried out, the metallic powder contains no more than 0.2 to 0.3 per cent C.

There is being considered at this time the installation of continuous rotary furnaces, in which the WO_3 will be reduced by gases of definite composition produced by a generator. If the temperature can be raised to the proper point, it will be possible to obtain tungsten entirely free from carbon.

In Germany, it is the practice to reduce the WO_3 by means of wood charcoal, with colophony as a binder. The proportions of the materials entering into the reaction are: WO_3 100 parts, wood charcoal 14.1 parts and colophony 2 parts. The crucibles containing the mixture are heated in a coke furnace. To avoid fracture of the crucibles, the coke is lighted at the top and the burning is continued in a uniform manner from top to bottom. The time consumed is 12 to 14 hr. The advantage of the oil-heated furnaces at Gaillonnet over this process is readily seen.

The tungsten powder made by the Gaillonnet process consists of small hexagonal crystals of average size 1.5 mm. It contains no tungsten bronzes. The composition of an average sample is as follows: W 98.67, Sn trace, Si 0.09, C 0.62, Fe 0.17, Mn trace, P 0.06, CaO 0.13, S trace, As and Cu none.

The British practice is to decompose the W mineral with carbonate of soda below the fusion point, while aiding the absorption of the oxygen required in the process by means of a mechanical raking arrangement. It is claimed that the yield is improved in this way.

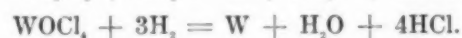
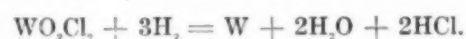
TUNGSTEN FILAMENTS

There are three methods of making tungsten filaments generally used in Europe. These are the substitution process first used by Just and Hanamann of Vienna, the wire-drawing process of Auer and Kuzel's colloidal tungstic acid process.

In the substitution process, a carbon filament is heated to incandescence in an atmosphere of hydrogen and tungsten oxychloride (WO_2Cl_2), whereby the tungsten gradually replaces the carbon and forms a metallic filament, according to the following equations:



As the carbon disappears the conductivity increases; the temperature is raised and the proportion of hydrogen is increased, the reaction proceeding as follows:



The success of the process depends on the pressure of the H. Too low pressure causes the C to disappear without replacement by W, as the C is changed to the oxide while the W remains combined with Cl in the form of a chloride. Too much H causes the reduction of the oxychloride to take place without the intervention of the C, whereby the metal merely covers the original filament.

The wire-drawing process was first used by Auer with osmium and later applied to tungsten. Powdered tungsten is agglomerated with an organic binder such as sugar, gum arabic, dextrine, etc., and a paste is formed which is made to pass through a diamond draw-plate. The threads obtained in this way are then calcined in a reducing atmosphere, so that the filament finally contains W and C. Current is passed through it so as to heat it up to 1,100 deg. C. in an atmosphere of H and water vapor. The latter reacts with the carbon and converts it to CO_2 , while the metal is protected by the hydrogen against the oxidation effect. After the carbon is burned off, the current is increased and the filament is gradually reduced to about three-fourths of its original length. It is found that a little H_2WO_4 added to the paste facilitates the oxidation of the C. Other substances having the same effect are the oxides of volatile metals, ZnO, CdO, and sulphides or S itself.

Kuzel uses as the binding agent colloidal tungstic acid. The metallic powder, finely divided and treated alternately with acids and alkalis, is converted to the colloidal form. When this is precipitated from the colloidal solution by an electrolyte, the gel that is obtained is well suited for use as a binding agent for the tungsten powder.

Wild-Barfield Electric Furnace

BY LANCELOT W. WILD, M.I.E.E.

THE Wild-Barfield electric furnaces are being manufactured primarily for the heat treatment of steel. They are made in three types—namely, radiation, muffle and salt bath. Of these the radiation type is the most popular. All these furnaces are fitted with the Wild-Barfield magnetic pyroscopic detector, which permits the furnace being worked by an entirely unskilled operator and insures the best results being obtained every time, as only by very gross carelessness can the steel be either under- or over-heated.

RADIATION FURNACE

Fig. 1 shows the construction of the furnace diagrammatically and the connections for alternating current circuits. Fig. 2 is a photograph of an 8-in. furnace in operation at Coventry, England.

The furnace consists of a refractory lining which is wound with a helix of nickel-chrome wire. The case is made of sheet aluminum, with a cast-iron stand and cast-iron top and doors. The space between the case and lining is filled in with lagging powder. Outside the casing is wound a single layer coil of enamel-insulated copper wire. This is known as the pyroscopic or detector winding.

The inner winding has two functions to perform. It acts as a generator of heat and it also acts as the primary of a transformer or induction coil, of which the detector winding forms the secondary.

From Fig. 1 it will be seen that in series with the heating winding is the primary winding of a piece of apparatus commonly known as the compensator. The compensator is also wound with a secondary winding so

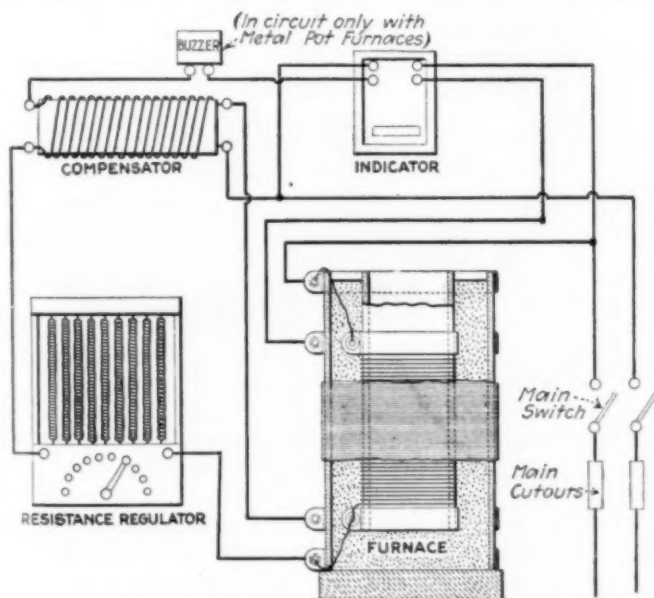


FIG. 1. WILD-BARFIELD FURNACE—CONNECTIONS FOR ALTERNATING CURRENT

as to form a similar transformer, and this secondary winding is connected in series with the detector winding of the furnace and the indicating instrument. The compensator secondary and the detector are in opposition and an iron core in the compensator is adjusted till their two voltages balance exactly and no current passes into the indicator. Any fluctuation in the main voltage or periodicity affects both the furnace and compensator alike, so that a steady current supply is not demanded.



FIG. 2. WILD-BARFIELD 8-IN. REDUCTION FURNACE. Output 30 lb. of tools per hr. Power consumption 4,200 watts.

secondary circuit ceases to flow, so that the pointer of the indicator returns to zero. If the steel is now withdrawn from the furnace and quenched, the finest grain with its numerous advantages will be obtained without fail.

The indicator consists of a light moving coil working between the poles of an electromagnet, which is energized from the mains. The instrument has a quick period of oscillation, is well damped, has large moving forces and is of really robust construction.

On continuous current circuits the indication is obtained in a slightly different manner. The alternating current indicator is replaced by a direct current galvanometer with mirror and scale. The connections otherwise remain the same. When a piece of cold steel is introduced into the furnace a momentary current is induced in the detector winding and a throw of the galvanometer spot is observed, the spot running off the scale and then returning to zero. If the steel is now removed while still cold, a throw will again be obtained, but in the opposite sense. If, however, the steel is allowed to remain in the furnace till it heats up, a direct current will be obtained in the detector winding, starting from the beginning of the Ac range and lasting till the steel has entirely passed through this range. Thus the signal is given for withdrawal of the steel when the galvanometer spot returns to zero.

The compensator is still required on direct current circuits to neutralize the effects of fluctuation of main voltage. Without the compensator the detector would be unworkable on ordinary circuits, as the galvanometer spot would be jumping about over the scale all the time.

Fig. 2 shows a small radiation furnace of a size that is very popular in England. It is largely used for jobbing work. Where it is used for mass production, it is generally worked by a girl. The articles if large are hung from a wire. If the articles are small and similar in size and quality of steel, they are arranged in some sort of a frame and are heated and quenched as one unit.

MUFFLE FURNACES

Muffle furnaces are constructed in the same way as radiation furnaces, the only differences being that the axis is horizontal instead of vertical. In cross-section the heating chamber instead of being circular has a flat top and bottom joined with semi-circular sides. This gives a flat floor on which the work rests and at the same time the shape insures the resistor wire lying snugly in position around the muffle. The absence of sharp corners is advantageous inasmuch as it also reduces the liability to cracking.

A muffle furnace fitted with pyroscopic detector is very suitable for treating small articles such as sewing needles. The needles are placed in a tray and are worried till all lie the same way. They are then sprayed with oil, to prevent them sticking together and the tray is placed in the muffle. When the signal is given, the tray is removed with tongs and the contents shot out into a tank of oil.

SALT BATH FURNACES

The use of salt bath furnaces is mainly confined to the treatment of screw gages. The very quick heating obtained, assisted by the pyroscopic detector to prevent overheating, considerably reduces the liability to distortion.

The first salt bath furnaces made consisted of a silica pot containing the salt. This pot was wound as in the radiation furnace. Silica was chosen for the pot, as this is the only material yet found which is entirely salt-proof. Many of these furnaces were used during the war for gage hardening.

The drawback to this pattern of furnace was that it was necessary to maintain the current constantly once the furnace was started, since if the furnace was once allowed to cool down, the expansion of the solid salt was sufficient to crack the pot on restarting.

Salt bath furnaces are now made for gage hardening which can be switched off at the end of a day's work. The inner pot is of metal and this is surrounded by a refractory cylinder on which is placed the winding. Provision has to be made for drainage, as the metal pot is not quite salt-proof.

The Wild-Barfield furnaces are being manufactured in England by Automatic & Electric Furnaces, Ltd., London. They have been exported to most countries, but there are none yet to be seen in the United States or Canada.

Gray's Inn Road,
London, W. C., England.

New Paint Products Recently Introduced

A new process developed in the treatment of the paint vehicle whereby pure red lead is present suspended in oil in such a state of fine division that it does not settle appreciably and does not harden in the can even on long standing is announced by the Paint Specialties Corporation of New York. This treatment results in a ready mixed product which is very uniform in texture, covers well, and flows easily, thereby enabling a great saving in time and material in its preparation and application, over the old method of mixing the paint on the job.

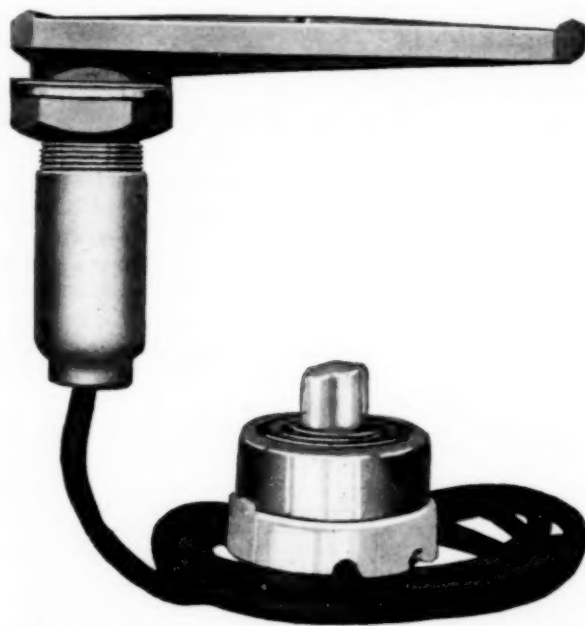
A black paint using a vegetable oil as its vehicle and capable of standing severe heat, acid and lye tests, and also possessing antiseptic as well as rust inhibitive

powers is also manufactured by the same corporation, at its plant in Jersey City. This paint is very adhesive and elastic and when applied to iron surfaces will stand severe bending strains, and changes in expansion and contraction due to weather conditions without showing signs of deterioration. It finds application on steel and iron structures subject to the action of sulphuric acid and sulphur fumes. Because of its antiseptic properties it is used for protecting the bottoms of ships to keep them from fouling.

A third new product, a waterproof paint suitable for cement, concrete, stone, brick and wood, is also manufactured in various colors.

Immersion Heater for Chemical Laboratory

A new immersion type water heater made by the Cutler-Hammer Mfg. Co., shown in the illustration, consists of nickel-chromium heating elements incased in a flat brass casting which protects them from mechanical injury. The casting is about 3 x 6 x $\frac{1}{2}$ in. in size, and makes a simple and durable heater from which is easily cleaned any sediment that may be deposited from the water. When protected in this



IMMERSION TYPE ELECTRIC WATER HEATER FOR MOUNTING IN THE BOTTOM OF THE CONTAINER

manner the life of the heating elements is increased, requiring less frequent renewals than with the ordinary immersion type heater.

This heater is particularly useful in the chemical laboratory for heating or evaporating water in any shallow container, and may also be used with glue pots, paste kettles, sterilizers and other apparatus.

To install the heater, a $1\frac{1}{4}$ -in. hole is drilled through the bottom of the container and the heater inserted from the top, so the extension through which the cord is run projects downward through the hole. Tightening the nuts and washers holds the heater rigid and prevents leakage.

By means of a snap switch on the heater cord three different heats may be obtained: 1,200 watts, 600 watts and 300 watts. Standard heaters are made for 110, 120 and 220 volts, and may be used on d.c. or a.c. circuits.

Synopsis of Recent Chemical & Metallurgical Literature

Pyrometers in Brass Foundry.—JOHN ARNOT read a paper before the Glasgow meeting of the Institution of British Foundrymen, in which he said that for the past two years he had been using couples made of nickel vs. nickel plus 9 per cent chromium for taking temperatures of molten metal before pouring. The two wires are encased for most of their length in a steel tube, leaving only a few inches of bare wire for immersion. Inside the tube they are insulated by asbestos woven to a tubular form, or by pieces of porcelain tube. The wires are welded together, and when the junction is burnt through they can be re-welded in a couple of minutes in the oxy-acetylene flame.

In molten brass or manganese brass at 950 to 1,000 deg. C. the couple lasts a very long time. In molten gun-metal the life of the junction depends on the temperature of the metal. At temperatures of 1,300 deg. C. and over the junction will last only one or two immersions, but at 1,150 deg. to 1,200 deg. C. perhaps six would be an average. The amount by which the couple is shortened each time the junction is burnt through is only 2 in. at most, so the actual cost of each immersion is very small.

After mentioning the fact that pouring temperature is undoubtedly one of the most important factors affecting the quality of castings, and giving some test bar results to substantiate this belief, he continues that one might imagine that the range of temperatures within which gun-metal is cast in foundries would be comparatively small. The writer is quite convinced that in the average foundry the casting temperature varies from about 1,100 deg. C. up to 1,300 deg. C. At Cathcart it has been found that the casting range of manganese brass is very small, and that for the soundest castings the temperature should be 970 deg. C. \pm 20 deg. C.

Coal Gas Byproducts in Germany.—The situation of the coal gas byproducts in Germany is outlined in the Aug. 14, 1920, issue of *Glückauf*, pp. 657-659. Of special interest are the following figures showing the variations in the prices of coal gas coke in four different parts of Germany for the period 1919-1920 (Table I) and of coal tar, ammonia and gas retort carbon for the periods 1913-1914, 1918-1919 and 1919-1920 (Table II.)

TABLE I. PRICE OF COAL GAS COKE, MARKS PER TON

		Munich	Berlin	Erfurt	Cologne
April	1, 1919.....	81.80	68.50	74.50	59.50
May	1, 1919.....	111.80	98.50	104.50	89.50
June	1, 1919.....	120.30	107.00	113.00	98.00
Oct.	1, 1919.....	142.30	129.00	135.00	120.00
Dec.	1, 1919.....	157.30	144.00	150.00	135.00
Jan.	1, 1920.....	190.80	177.50	183.50	168.50
Feb.	1, 1920.....	304.80	259.95	297.50	250.95
March	1, 1920.....	366.90	322.05	359.60	313.05
April	1, 1920.....	410.15	365.30	402.85	356.30

TABLE II. PRICE OF COAL GAS TAR, AMMONIA AND RETORT CARBON (MARKS PER TON)

	Tar	Ammonia	Retort Carbon
1913-1914.....	31.51	83.78	62.51
1918-1919.....	55.25	63.34	103.21
1919-1920.....	215.47	100.83	160.21

Swedish Electrometallurgical Production of Iron, Steel and Alloys.—According to the *Sverige Officiella Statistik (J. du Four Electrique, Sept. 1, 1920, p. 116)*, the electrometallurgical production of iron, steel and ferro-alloys for 1917 and 1918 were:

Pig Iron. There are eighty plants, comprising 146 producing apparatus, of which 123 are in operation. Among these there are ten electric blast furnaces and eight electric furnaces. The total production in tons was:

	1917	1918
Pig iron by electric blast furnace.....	57,793	59,176
Pig iron by electric furnace.....	9,266	16,508
Pig iron by ordinary coke blast furnace.....	79,759	74,140
Pig iron by charcoal blast furnace.....	661,695	597,608
Pig iron by coke and charcoal blast furnace.....	20,456	14,390
Total.....	828,969	761,822

A charcoal blast furnace consumed 57.4 hl. per ton of pig iron. For electric pig iron 24.8 hl. of charcoal was required per ton of iron, the charcoal acting simply as the receiving agent. A coke blast furnace required 1.5 tons of coke per ton of pig iron.

Steel. The production of steel in 1918 was 545,499 tons, of which 13,089 tons—i.e., only 2.4 per cent—was produced by the electric furnace. There are twenty-eight electric furnaces installed, of which two are induction furnaces and twenty-six are of the electrode type.

Alloys. The following table gives the kind and amount in tons of ferro-alloys produced in 1917 and 1918:

	1917	1918
Ferrocilicon.....	19,240	10,705
Silico-aluminum.....	1,002	354
Silicomanganese.....	4,367	1,305
Silico-aluminomanganese.....	1,330	469
Ferromanganese.....	1,182	2,123
Ferrochrome.....	802	258
Ferrotungsten.....	.....	.....
Ferromolybdenum.....	8	.....
Spiegel.....	.....	733

Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red Hardness.—There has been more or less mystery attached to certain well-known phenomena connected with the heat treatment of high-speed steel. Anticipating a disappearance of the mystery with the acquirement of sufficient pertinent experimental data, the physical characteristics and the microstructure of a standard type of high-speed steel as affected by quenching temperature, tempering temperature, and treatment below ordinary temperatures were studied and reported in Scientific Paper of the Bureau of Standards No. 395, by Howard Scott.

The experimental results obtained appear to warrant the following conclusions: (1) Secondary hardening necessitates prior partial austenitization produced by the high-temperature treatment; (2) the variations with heat treatment in physical properties and microstructure of high-speed steel are analogous to those of hypereutectoid carbon steel with the exception of the microstructure of hardened but untempered steel; (3) red hardness is largely a function of the composition of the matrix and is only comparatively slightly affected by the amount of dissolved carbide. Three reasons are given for the established advantages derived from the use of the high-temperature heat treatment, namely, increased red hardness, increased initial hardness, and reduced brittleness.

Current Events

in the Chemical and Metallurgical Industries

The Social Function of the Engineer

The New School for Social Research, 465 W. 23rd St., New York City, in conformity with its general purpose to help increase our knowledge of human nature and social institutions, to establish and measure social facts, to develop a scientific attitude toward present political, social and economic problems, recognizes the important position of the trained engineer in our social structure. The school has, accordingly, established a course of study, conference and research in the social function of the engineer, which will be given during the coming scholastic year, beginning Oct. 13.

Briefly, this course will comprise a series of lectures and conferences covering the relations of the trained engineer to the present social order. His status and responsibility as a technician, as an administrator and as a consultant will be investigated. The limitations to his functions by the existing economic order and its influence on his ideals will be developed. The codes of ethics of the engineering profession as submitted by the various engineering societies will be examined and their derivation and significance determined. Engineering education as influenced and controlled by the economic and social systems in America and Europe will be discussed. The efficiency of industry from the engineer's point of view under private enterprise, co-operative enterprise, and governmental regulation will be studied. Lastly, the relation of the engineer to labor and the problems of production will be investigated. Practical developments and illustrations will be brought out and discussed. Experienced engineers in various fields of endeavor will contribute to the lectures and conferences. O. S. Beyer, Jr., formerly of the University of Illinois, will administer this course.

Wants Sulphur Conserved

Some fertilizer works are returning to the use of Spanish pyrites with reluctance. During the war they were forced to burn pure sulphur and some would like to continue the use of that material. Officials in Washington have received protests against the policy of the sulphur-producing companies in declining to sell their product at prices which would compete with Spanish pyrites. It is claimed that the domestic producers could run imported pyrites out of the market and still have an adequate profit on their sulphur. The Government's sulphur specialists, however, do not regard that position sympathetically. They are of the opinion that this high-grade material should be conserved as much as possible, especially as long as low-grade material can be obtained so readily and cheaply.

Mining Engineers Join the Federation

By appropriate official action the American Institute of Mining and Metallurgical Engineers has decided to join the Federated American Engineering Societies. This is the third of the so-called founder societies, or large national institutes, to join the Federation.

To Speed Graphite Tests

Now that the ceramics station of the Bureau of Mines at Columbus, Ohio, has demonstrated that the United States has better bonding clay than ever has been imported, it is prepared to continue its graphite tests on a larger scale. The domestic graphite to be used in this experiment work will be largely the Alabama product. Other graphite deposits throughout the country are known to exist, but since little work has been done on them difficulty has been experienced in securing representative samples. This is especially the case since about 400 lb. is needed for even a limited amount of experimental work.

The Columbus station is obtaining some very satisfactory results from its dolomite-magnesite investigations. The experiments indicate that lime can best be separated from dolomite by adding sufficient sulphuric acid to convert the lime into sulphate and washing off the magnesium hydroxide.

Through an arrangement with the Ohio Malleable Iron Co. the Columbus station is being given an opportunity to test out the various types of refractory brick. The company is allowing these bricks to be put in its furnaces and is assisting in keeping a record of their performance. Some preliminary work is being done on the effect of sillimanite formation on the strength of refractories at furnace temperatures.

Foundry and electric furnace operators are to hold meetings in Columbus for the week ending Oct. 9. During their presence in Columbus various tests on refractories will be made at the ceramics station. On that occasion Superintendent Stull will point out the need for more work on electric furnace refractories. Most of the work which has been done at the station has dealt with combustion furnace refractories. He will suggest the possibility of co-operative work with the bureau so as to make such an investigation possible.

Barber Asphalt Paving Co. Plant Destroyed by Fire

The plant of the Barber Asphalt Paving Co. at Maurer, N. J., was practically destroyed by a fire Sunday, Sept. 26. The conflagration started in one of the 20,000-bbl. storage tanks, which foamed over and spread burning flux about promiscuously, igniting and destroying the machine shop, power house, boiler room and roofing plant, railroad cars, etc. Tugs from the railroads and from New York were rushed to the scene, together with the Firefoam apparatus of the Standard Oil Co. of Bayonne, and the fire was finally put under control, although the ruins were still smoldering for two days after and flux and asphalt which was softened by the great heat was lying four and five inches deep over the yard.

The wharf, main office and laboratory were not injured and the plant was largely covered by insurance.

The efficiency of Firefoam as a preventive was well shown by the fact that the fire in all the tanks except one was extinguished and only one tank was destroyed.

Work of the Bureau of Chemistry on Phthalic Anhydride and Furfural

The Secretary of Agriculture in a recent public address told the story of the work of the Bureau of Chemistry on phthalic anhydride as follows:

When the importation of chemicals from Germany was stopped by the war, a shortage of phthalic anhydride developed in this country almost immediately. This product, which is used in the manufacture of a number of important dyes and drugs, had previously been produced only in Germany and Austria. Attempts were made by manufacturers in this country to use the German process, but it was found to be costly and difficult to handle.

Experiments then were conducted in the Color Laboratory of the Bureau of Chemistry to devise a new process in which air instead of mercury and sulphuric acid, which the Germans had used, could be employed. A successful method was found, and the Bureau of Chemistry co-operated with manufacturers in placing the new process on a commercial basis. As a result, we are not only producing phthalic anhydride in this country but we are also exporting it to Switzerland in competition with German manufacturers.

Statistics show that the difference between the cost of producing the product by the German method and the new process results in a saving of at least \$700,000 per year on the basis of the present production. The production, however, is increasing and, with this increase, it is expected that the cost of manufacture will be still lower by the new process. Phthalic anhydride has been sold recently in this country for 45c. per lb., while during the war it sold as high as \$7 per lb.

It has been estimated by those who are acquainted with the phthalic anhydride market that the new process is saving enough each year to pay for the entire annual appropriation of the Bureau of Chemistry. Moreover, it has made possible the manufacture in this country of many dyes and other chemical compounds which could not have been made successfully except for the discovery of this process.

In the same address Secretary Meredith also said:

Corn cobs, which, from the beginning of agriculture in America until now have been a waste product, are about to become an important raw material in manufacture. Capital at various places is becoming interested in the establishment of cob utilization plants. This is all due to a set of discoveries made in the Bureau of Chemistry by which it was found that the entire content of the corn cob can be made into highly useful articles. From it our chemists produced a very excellent adhesive. After the high grade adhesive is removed, a considerable quantity of a lower grade product can be made and the residue is practically pure cellulose, from which it is possible to manufacture a great number of commodities, including a very good quality of paper. Some valuable lime products also are recovered. After all these processes had been worked out, it was discovered that a considerable quantity of a very costly chemical—furfural—was being lost. This is now saved as a byproduct and an even larger quantity of it can be produced by redistillation of the adhesive. Before this discovery was made furfural used to sell as high as \$20 a lb.. Furfural is a basic intermediary in dye manufacture and, in addition, is so effective as an insecticide that it was used for that purpose even when it sold at \$20 a lb.

Gas Casualty Figures

Figures compiled by the Surgeon-General of the Army show that of the 258,338 casualties among the American troops during the war, 27.4 per cent were caused by gas. Of the 266,112 wounds inflicted upon 224,089 Americans admitted to hospitals 33.4 per cent were caused by gas. Hundreds of thousands of hours were consumed in training men in bayonet work, but actual warfare developed that the bayonet was relatively an unimportant weapon. Hand grenades were responsible for 1,156 wounds, pistols 257, sabers 14, bombs from airplanes 150 and bayonets 245.

Chemical Warfare Post Meeting

The meeting of the Chemical Warfare Post of the American Legion was called to order by the president at 8:30 p.m., Sept. 22, 1920, in the conference room of the Grand Central Palace. There was a short talk by the president, followed by a talk by General Fries, Dr. Walker and Mr. Burrell.

Mr. Burrell took charge of the meeting while the election of new officers was being taken care of. A committee consisting of Dr. Walker, Dr. Bogert, Dr. Woodruff and Mr. Burton was appointed to submit nominations. The committee withdrew for about ten minutes and then submitted names for nomination. The list was voted upon as a whole just as it stood and Leslie T. Sutherland was elected commander; Mr. Mayo-Smith, vice-commander; S. M. Cadwell, secretary; and Dr. Zinsser, treasurer. General Fries, Dr. Walker, Mr. Burrell, Mr. Dewey, Mr. Dorsey, Dr. R. F. Bacon, and M. Bacon were appointed as the executive committee.

It was resolved that the Chemical Warfare Post of the American Legion go on record as advising Representatives and Senators that they are in favor of the passage of the dye bill.

There was considerable discussion as to just how the Chemical Warfare Post can be of assistance to the Chemical Warfare Service. This is to be taken up by the executive committee as well as other questions which came up, such as the establishment of posts in various parts of the country and time and place of the next meeting.

Prospects of Industrial Alcohol in England

FROM OUR LONDON CORRESPONDENT

London, September 9, 1920.

The meeting of the Chemical Section of the British Association threw some further light upon the production and use of power alcohol, upon which it is expected that the British Empire will to some extent be dependent in the future. The quantities obtainable from the ethylene present in coke-oven gases seem to be insufficient greatly to affect the question and the general consensus is that the future lies with a successful method of producing alcohol from carbohydrates by fermentation and to a smaller extent with its production from wastes of the pulp mills of Canada. Alcohol produced by synthetic methods from calcium carbide via acetylene seems to have failed in Switzerland, and it is pointed out that if, as an alternative, calcium cyanamide is used as a fertilizer for potatoes, the indirect yield of alcohol would be four times that obtainable by direct conversion. Captain Desborough pointed out that to place alcohol on the market at 75c. per Imperial gallon, the raw material should not cost more than 25c., which on the basis of 120 gal. per ton of raw material would make it necessary for the manufacturer to buy at an average price far below that which is quoted today for the cheap sources of carbohydrates and that until prices fall to the maximum economic level there can be little progress. The sudden increase of about 15c. per gal. in the price of all grades of petrol, which was recently imposed by the marketing companies, makes the position more favorable, and there can be little doubt that if the price of petrol reaches \$1 per gal., as is confidently predicted in some quarters, there will be an immediate impetus given to schemes for the production of power alcohol on the largest scale.

Farmers Buy Little Nitrate

Only seventy-five tons of nitrate of soda has been sold by the War Department under the law which made available 100,000 tons of that material for sale direct to consumers. The act authorizing the sale expired by limitation Sept. 30.

When the sale of a portion of the War Department's reserve of nitrate was being discussed in Congress, the expectation was that there would be ready demand for the entire amount. The War Department was opposed to depleting its reserve by one-third, but Congress was practically unanimous in its support of the legislation. Instead of the farmers rushing to purchase the material, practically no interest was shown. Fifty tons of the amount went to a chemical company at Nitro, W. Va. The remainder was purchased by farmers mainly in one-ton lots.

The Government offered the nitrate at \$88.90 per ton. It was estimated that at that price there would be neither profit nor loss to the Government in the transaction. During a portion of the period at least the Government's price was considerably less than the commercial price of nitrate of soda. It was explained that the small amount sold was due to hesitancy on the part of farmers to depart from their established custom of getting fertilizer from their local dealers. In addition, the material came on the market very late in the season and there seemed to be no desire to buy the material to carry over.

Taking Leaf From Germans' Book

General Amos A. Fries, the head of the Chemical Warfare Service, has made one of his foremost policies the adoption at the earliest practicable date of a co-operative agreement with chemical industries which will permit of the equipment of their plants and the organization of their work in a way to make their plants readily convertible to war purposes. By being thus forehanded, he believes much less interference with industry will be necessary in case of war than otherwise would be necessary. While the chief advantage to be obtained would be the ability to secure quantitative production of gas warfare materials almost immediately after the declaration of war, General Fries believes it would be of very material advantage to have such an agreement with as many chemical plants as possible so that each could continue a portion of its regular output. The matter is to be the subject of immediate study and it is thought that ways can be found for making necessary arrangements without any important change of existing practice or of machinery types.

Experiments on Cerium Alloys

A series of experiments are to be conducted by the Bureau of Mines at its field station at Ithaca, N. Y., on alloys containing cerium. Particular attention is to be given non-ferrous alloys, but experiments will be conducted on metallic cerium and its alloys in connection with the manufacture of steel. The work is under the immediate direction of Dr. H. W. Gillett, and is being done under a co-operative agreement with the Welsbach Co. of Gloucester City, N. J.

The experiments which are being conducted at the Ithaca station in co-operation with the Vanadium Corporation of America are to be continued. This work largely has to do with the use of molybdenum in steel making.

Chemicals Furnish Big Tonnage

Chemicals and explosives to the extent of 1,960,190 tons were carried as revenue freight by the class 1 railroads of the United States during the first three months of 1920, according to figures made public by the Interstate Commerce Commission. These roads carry 91.8 per cent of the country's freight. The total amount of fertilizers transported during the period under review was 3,652,612 tons.

The distribution of the tonnage furnished by chemicals and explosives is as follows: Originating on roads in the Eastern district, 1,225,908 tons; in the Pocahontas district, 87,379 tons; in the Southern district, 288,532 tons; in the Western district, 358,371 tons.

These and other figures of interest to the chemical industry are expressed tabularly as follows:

Commodity	No. of Tons (2,000 Lb.)
Chemicals and explosives.....	1,960,190
Fertilizers (all kinds).....	3,652,612
Vegetable oils.....	279,939
Sugar, sirup, glucose and molasses.....	1,422,487
Pulp-wood.....	1,345,813
Cottonseed and products (except oil).....	1,582,141
Packing house products (other than fresh meats).....	617,665
Hides and leather.....	318,444
Coke.....	7,075,275
Iron ore.....	3,215,109
Other ores and concentrates.....	5,219,500
Base bullion and matte.....	195,321
Clay, gravel, sand and stone.....	15,766,002
Crude petroleum.....	1,529,749
Asphaltum.....	251,057
Salt.....	725,795
Other products of mines.....	1,418,286
Iron, pig and bloom.....	430,546
Rails and fastenings.....	90,286
Bar and sheet iron, structural iron, and iron pipe.....	221,719
Other metals, pig, bar and sheet.....	23,350
Castings, machinery, and boilers.....	88,835
Cement.....	185,137
Brick and artificial stone.....	499,934
Lime and plaster.....	97,518
Sewer pipe and drain tile.....	56,063

C.W.S. to Work on Ethylene

Experiments are being begun by the Chemical Warfare Service in an effort to devise means which will permit the development of ethylene as a separate commercial commodity at gas works, byproduct plants and at oil refineries. If the way can be shown whereby private enterprise can afford to develop this byproduct it will greatly simplify mustard gas manufacture.

Due to the fact that ethylene is difficult to liquefy, the simplest and most convenient practice would be to bring the sulphur monochloride, the other ingredient in mustard gas, to the ethylene, just as iron ore is brought to coal. Another advantageous factor in securing the commercial production of ethylene is the fact that in time of war mustard gas would be made at a large number of small plants rather than in a few large ones. It would be difficult to get appropriations for the maintenance of large plants in stand-by condition in peace time, whereas considerable preliminary preparation could be made for utilizing this byproduct in private plants in case of an emergency.

Manufacture of Nitrocellulose

In the report of Mr. Schlatter's paper on nitrocellulose (p. 591, Sept. 22, 1920), the percentage of nitrogen referred to in the third paragraph as marking the approximate dividing line with respect to solubility in ether-alcohol should have been given as 12.8 instead of 12. The third sentence of the next paragraph should read: "It has been found that the nitration products of impurities in the cellulose as well as the lower nitrates and sulphates of the pure cellulose are the causes for instability."

Chemists Submit Ideas to C.W.S.

That the chemists throughout the United States are much interested in problems confronting the Chemical Warfare Service is indicated by their readiness to submit ideas and suggestions. These are reaching General Fries in increasing numbers. He is very anxious that this practice be encouraged, as many valuable ideas thus submitted have been put into practice.

As an example a suggestion came in from an unknown writer that a cloth be impregnated with anti-dim material for use in the prevention of fogging of the eyeglasses in gas masks. As a result an investigation was made and a cloth has been developed which is far more satisfactory than the stick of anti-dim material which has been in use.

The new cloth is 4 in. square and can be tucked in any pocket with little danger of its being lost.

Fire at the Butterworth Judson Plant

Fire started in the chemical and dye plant of the Butterworth Judson Corporation at Newark, N. J., Monday, Sept. 20, and destroyed several units. Four buildings were totally destroyed and several others damaged. Because of chemical and acid fumes the firemen were greatly hampered, but finally got the fire under control and prevented the further spread of the conflagration. Loss due to destruction of chemical stocks and buildings is estimated to be approximately \$500,000.

Texas Gulf Sulphur Co. Loading Plant Burns

Fire of unknown origin started at 1:50 Thursday morning and totally destroyed the 800-ton loading plant of the Texas Gulf Sulphur Co. on Pier 35 at Galveston, Tex. Although the company had 30,000 tons of sulphur in storage, there was practically no loss of this material and the plant was adequately covered by insurance.

The fire will in no way interfere with the company's business, as it has ample facilities for loading and shipping at Pier 14 and also at Texas City.

Conference With Officials on Chemistry of Cyanamide

As a result of the reports made at the Chicago meeting of the American Chemical Society by officials of the Department of Agriculture as to the changes which occur in cyanamide in mixed fertilizers, the matter has been taken up at conferences in Washington between representatives of the American Cyanamid Co. and the Government officials interested.

New Envelope Plant Established

A new company for the manufacture of envelopes, known as the Laubscher Envelope Co., has been formed in Springfield, Mass. It will be incorporated for \$1,000,000.

The manufacturing plant will be located on the Westfield River at Mittineague, Mass., about three miles from Springfield.

Demand for Radium Increasing

The price of radium five years hence will be double its current price, in the opinion of a radium specialist in Washington. He points to the increasing demand for radium products and to the lack of encouragement which is being given to the mining of radium ores as reasons for his conclusion.

Book Reviews

A TEXT BOOK OF INORGANIC CHEMISTRY; VOL. IX, PART I, COBALT, NICKEL, THE PLATINUM GROUP. By *J. Newton Friend*. Large octavo, 366 pp., illus.; price \$6. London: Charles Griffin & Co.; Philadelphia: J. B. Lippincott Co.

A very timely book, seeing the great activity of chemists along these lines. Cobalt is being used so liberally in alloys such as stellite and in high-speed steels that its metallurgy and the properties of its compounds have taken on considerable importance. There is also great activity in the metallurgy of nickel, and great need of chemical investigation in the separation of metals of the platinum group. In many respects the book is admirable, such topics as the author is particularly familiar with being very well handled—such as discussion of the relations of these metals to each other, their complex salts, the chemical analysis of metals of the platinum group; in a few respects the compilation is disappointing—thermochemical data are conspicuous by their nearly complete absence, there are indications of looseness in proofreading and sometimes in statement of essential facts, such as the temperature at which iron loses its magnetism (p. 7). The minor defects seem to be the natural result of one author trying to cover too much ground in too short a time. If used discriminatingly, the book can be very useful.

J. W. RICHARDS.

* * *

THE MANUFACTURE OF CHEMICALS BY ELECTROLYSIS. By *Arthur J. Hale*, xi + 80 pp., cloth. Price \$2. New York: D. Van Nostrand Co.

This volume forms a portion of a treatise of electrochemistry edited by Bertram Blount. It is divided into seven chapters, dealing with the following subjects: 1. Electrolytic Hydrogen and Oxygen, Ozone. 2. Production of Persalts and Hydrogen Peroxide. 3. Nitric Acid, Hydroxylamine, Hydrosulphites, Fluorine. 4. Electrolytic Preparation of Pigments and Insoluble Substances. 5. Electro-Osmotic and Electro-Colloidal Processes. 6. Electrolytic Reduction of Organic Compounds. 7. Oxidation and Substitution of Organic Compounds.

It will be seen that the contents of this volume partly overlap those of "The Applications of Electrolysis in Chemical Industry," by the same author, reviewed in this journal, vol. 20, p. 438.

The present volume claims to give "a complete and up-to-date account of processes now in use," but the omission of any account of the electrolysis of alkali chlorides throws out this claim.

With the exception of the first chapter, there is too little description of apparatus and procedure for a monograph on the "manufacture" of chemicals, and many reactions are included which have been worked out only on a laboratory scale and are therefore out of place. This monograph does very well, however, as a description of electrochemical reactions.

M. DE KAY THOMPSON.

* * *

PRACTICAL STANDARDIZATION BY CHEMICAL ASSAY OF ORGANIC DRUGS AND GALENICALS.

By *A. B. Lyons, F.C.S.* Cloth bound, 397 pp. Price \$3.50. Detroit, Mich.: Nelson, Baker & Co.

The scope of the book, as is stated in the title, is restricted to organic drugs and galenicals. This includes, of course, alkaloidal assaying, which comprises 170 pages. In this connection the author has assembled a wealth of material which has never before been collected in a single article. Much of this portion of the work is an amplification of his earlier published book (1886) on Pharmaceutical Assaying, which was the first of its kind.

Much detail is given under the general principles and theory of the subject of drug assaying, and one of the most valuable features, which is consistently found throughout the

whole book and which might be followed with advantage by many other authors of works on chemical analysis, is the frequency with which references are given to the literature in order that the original reference may be consulted by those who desire to do so. Another excellent feature of the book is the space that has been given to the determination of the active principles in non-alkaloidal drugs and preparations, as cantharides, convallaria, digitalis, etc., as well as the cathartic drugs, aloes, jalap, podophyllum, rhamnus barks, etc. Chapters are also found upon the assay of essential oils, glandular extracts, organic principles and synthetics (including those from coal tar, of course), carbohydrates and digestive enzymes.

The book concludes with a table of molecular weights, an excellent list of apparatus required for carrying out all of the processes described in the book and a list of the less easily obtained reagents.

An index of nearly 400 titles completes the book.

The only criticisms that are apparent to the reviewer are, first, that there is evidence of hasty preparation, especially in assembling the material. For instance, the section on general principles of alkaloidal assaying might have well been attached to the particular chapter on that subject and the same is true of the chapter on volatile oils. Another is that it is in no sense of the word a beginner's book, and the tyro is likely to be confused in many instances where three or four alternative methods of assay are given for a drug with no indication of preference or advantage of one over the rest.

The book is an invaluable addition to the pharmaceutical analyst's library and will find a constant use in every control laboratory. Dr. Lyons is to be congratulated upon having made such a valuable contribution to scientific literature at an age when most men are content to sit idly by and watch the younger men work.

CHARLES H. LAWALL.

Personal

CARL BERGQUIST has been stationed at the Bureau of Standards as research associate by the Corn Products Refining Co., to work in certain investigations of starch and dextrine, particularly on the method of measuring plasticity of these materials.

A. V. BLEININGER, until recently head of the division of ceramics of the U. S. Bureau of Standards, has resigned to accept the industrial management of the Homer-Laughlin China Co., East Liverpool, Ohio.

J. R. CAIN and S. L. PETERSON have been appointed, respectively, as research associate and research assistant in chemical metallurgy to work at the Bureau of Standards. Mr. Cain is working thus jointly for the American Rolling Mill Co. and the Metal & Thermit Co. Mr. Peterson is stationed at the Bureau by the American Rolling Mill Co.

ZENAS W. CARTER has resigned as manager of the Material Handling Machinery Manufacturers' Association to accept the position of assistant to the president of the F. C. Austin Corp.

Major H. F. DOIDGE, of the Thames Paper Co., Ltd., Purfleet, Essex, England, with a party of inspectors, is visiting the large paper plants of the United States.

W. A. HAMOR, F. F. RUPERT and E. R. EDSON, of the Mellon Institute, have returned to Pittsburgh after several weeks' field work at the plants of industrial fellowship donors in the New England section.

P. C. HOLDT has been designated as research associate to work at the Bureau of Standards, representing the American Paint and Varnish Manufacturers' Association. He is appointed through the agency of the Institute of Industrial Research, Washington, particularly to study problems of viscosity and plasticity of paints and paint materials.

H. E. HOWE, of the National Research Council, has been designated as executive secretary of the board of trustees of the Tables of Critical Constants. In this position Dr.

Howe will have immediate charge of the publicity and related activities essential for completion of an organization which it is expected will ultimately prepare and publish these tables.

CHARLES L. JOLY, of Washington, D. C., has been added to the list of Majors who have been tendered appointments in the Chemical Warfare Service.

ALAN LEIGHTON, a chemist who has been in the service of the Bureau of Mines at Pittsburgh, has been transferred to the Bureau of Animal Industry in the Department of Agriculture.

Dr. L. F. NICKELL, formerly assistant general superintendent of the St. Louis plant of the Monsanto Chemical Co., has been appointed general superintendent of all the East St. Louis plants of the company.

Dr. C. W. PORTER, associate professor of chemistry at the University of California, spoke before the California Section of the American Chemical Society on Oct. 1, on "Trivalent Carbon."

LOUIS S. POTSDAMER, of the Chemical Pigments Corp., of Philadelphia, Pa., is now in charge of the sales of ground water floated barytes produced by that corporation.

ALLEN ROGERS is to be the recipient of the Grasselli medal at the joint meeting of the New York Section of the Society of Chemical Industry and the Société de Chimie Industrielle on Oct. 8.

E. J. RUH has been appointed a research assistant at the Bureau of Standards by the International Nickel Co., to assist in certain metallurgical studies in nickel alloys.

WALTER SCHMIDT, of the Western Precipitation Co., of Los Angeles, Cal., has just returned from Europe.

Dr. JAMES K. SENIOR has resigned from the research staff of the Procter & Gamble Co., of Cincinnati, Ohio.

SAMUEL TREPP, who has been with the Marden, Orth & Hastings Corp. for five years, has resigned his position to become associated with Williamson & Co., brokers and purchasing agents, at 28 Burling Slip, New York City. Mr. Trepp recently returned from a six months' business trip to Europe, where he visited Scandinavia, Germany, Holland, Belgium, France and England.

Obituary

MICHAEL P. GRACE, of New York, chairman of the board of directors of William R. Grace & Co., exporters, importers, shipowners and bankers, died week before last in London. Mr. Grace was also the head of Grace Bros. & Co., of London, and a brother of William R. Grace, a former mayor of New York City, who was the founder of the firm bearing his name. He was seventy-eight years old and was in London on his annual business visit.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Pa., October 1, 1920.

The heavy deliveries of steel made lately, by reason of the moving of all or nearly all of the large quantities of steel that had accumulated during the period of car shortages, have put the average consumer of steel in fairly comfortable position, and some consumers have as large stocks now as they care to carry, particularly as they are looking forward to there being a period of somewhat lighter industrial activity generally. The market in steel products is correspondingly quiet.

AUTOMOBILE AND STEEL PRICES

The reductions announced in automobile prices by a number of the manufacturers seem to have had a sentimental influence upon the feeling in many commodity

markets, an influence not entirely justified by the actual circumstances, since the automobile manufacturers had been particularly vigorous in pushing their prices up. In the steel market the feeling is that buyers of steel manufactures generally will be disposed to look for lower prices, but that the particular incident of automobile prices coming down will have little or no influence upon prices for regular mill products as sold by the steel mills. When steel prices are marked for declines the actual reductions occur through buyers offering attractive orders. That is something the automobile trade cannot do at this time. Operating full the automobile industry could not engage more than 7 per cent, at the outside, of the steel-making capacity. Its actual consumption of steel this year promises to be between 4 and 5 per cent of the total output. With the lighter operation before the automobile industry even such a tonnage could not be offered if the automobile makers were in position to buy, but as a rule they are not in such position. Many have contracts running through the remainder of this year, while one of the largest interests is understood to have a contract running through next June. Being with the Steel Corporation, and therefore at Industrial Board prices, this would be a favorable contract to the buyer.

Apart from the matter of whether there is opportunity for barter between steel makers and automobile makers, the steel producers refuse to admit that automobile price reductions furnish occasion for reductions in steel prices. They point out that automobile prices had been sharply advanced as one point, while another point is that no conceivable reduction in steel prices would absorb much of the price reductions now being made. Roughly speaking, automobiles sell at 50@75c. a lb. for the lighter cars and at \$1@2 a lb. for the larger and higher priced cars, not much more than half the total weight at the outside being in rolled steel such as is supplied by the steel mills. The steel mill prices, on the other hand, are represented by a small number of cents per pound.

CORPORATION AND INDEPENDENTS

There have been three markets in steel products for months past, the Steel Corporation market, at the Industrial Board prices of March 21, 1919, the general independent market, at which large independents booked their customers for considerable distances ahead, and the special delivery premium market involving small tonnages for prompt shipment and made chiefly by the smaller independents. The last named market has already practically disappeared. The next development is for the second market to decline to the Steel Corporation level, that being something that is generally expected. On a weighted average of the different commodities the difference between these two markets is nearly if not quite \$20 a net ton, or a cent a pound.

As to the Steel Corporation prices, scarcely anyone seems to expect them to decline. The Steel Corporation is booked far ahead and its customers, in view of the much higher prices their competitors have had to pay to independents, feel very kindly to the corporation, so that it is hardly conceivable the corporation would have any occasion to make reductions in order to hold its trade. That the automobile industry itself would be quite unable to budge the corporation in its prices is obvious from a simple comparison. An automobile that has been in the \$2,000 to \$3,000 class and which might have its price reduced \$100 to \$300 involves the consumption of less than one ton of steel. A dollar a ton, therefore, would mean nothing to the automobile manufacturer, but to the Steel Corporation a dollar a ton on its product is the same amount as a 3 per cent dividend on its common stock, the corporation's output at 90 per cent of capacity being about 14,500,000 tons of steel products for sale, while its common stock outstanding is about \$508,000,000. Naturally the corporation would not make special prices to the automobile industry.

STEEL PRICES

With the disappearance of fancy premiums for prompt deliveries the independent steel market is more closely quotable. The ranges between the Steel Corporation and the ordinary independent prices are approximately as

follows: Bars, 2.35@3c.; shapes, 2.45@3.10c.; plates, 2.65@3.25c.; nails, \$3.25@\$4.25; pipe, 57½ per cent off list to 54 per cent; nails, \$3.25@\$4.25; blue annealed sheets, 3.55@5.50c.; black sheets, 4.35@7c.; galvanized sheets, 5.70@8.50c.; tin plate, \$7@\$9. Generally speaking, the upper prices here given are prices that independent mills are disposed to maintain, if possible, as long as they have so much more contract tonnage on books than there is conceivably obtainable by cutting prices and seeking fresh business, for much of the contract business would be jeopardized if open cuts were made. The present outlook is that substantially these prices will be maintained for a few weeks, possibly until the new year, but there is always the possibility of an accident, for if any mill saw another mills securing business at cut prices and with itself unable to operate to advantage it would probably go and do likewise.

PIG IRON

The chief thing that has kept pig iron from declining in many of the districts is the fact that no inquiries of sufficient attractiveness have appeared, and in the main the market is quotable at former prices, although these prices are technical rather than representative of actual values. An illustration of how readily pig iron can decline upon occasion is furnished by foundry iron at valley furnaces. This market was suddenly advanced, late in August, from \$46 to \$50, furnace, enough sales being made at \$50 to establish that figure as the accepted market quotation. On a lot running into four figures, however, a valley producer has done \$47, and the trade now regards that figure as the new market.

The Chemical and Allied Industrial Markets

New York, October 1, 1920.

The slight change for the better which has taken place in the chemical market is hardly perceptible—in fact, the figures remain about the same—but the general opinion, based on improved inquiry, seems to point to a rising market in the near future. There is a noticeable lack of shading of prices that was so much in vogue among second hands recently and quotations are for the most part those of producers. But the actual trading being done is so far below normal as to make these figures merely representative of market conditions. The high level reached in *salt cake* is well sustained and offerings are hard to find below \$50. This figure is practically double the quotation six months ago of \$28@\$32 per ton. Offerings of *bleaching powder* have been few, there having been no recent arrivals, while the prevailing price on material due to arrive is about 8c. per lb.

Producers are entirely in command of the *aqua ammonia* situation, which has remained firm at 9¼@10c. per lb., and although there is nothing resembling a surplus of this material in the hands of manufacturers, the 26 deg. grade can be obtained for near shipment at the above figures. *Copperas* and *barium chloride* both showed signs of weakening some time ago, but so far the lowest actual sale of the former seems to be around \$2.25 per cwt., while the shipments of the latter from abroad are still \$140 per ton. The excellent demand for *glaubers salt* has kept this item steadily advancing and it is so difficult to obtain material from producers, who are behind on contracts, that a reasonable amount of leeway is to be allowed in the quotation of \$2.25@\$2.60 per cwt. *White arsenic* also felt the stimulus of heavier inquiry and is firm at 15c., and *red* fell off slightly, with a low price of 16c. per lb.

COAL-TAR PRODUCTS

There is little to be said in enlargement of recent reports of this market, as the general tone of weakness is still noticeable. And also the "show" material affected the usual routine of business to the extent of putting an end to whatever activity has been going on in the downtown district. However, it was merely the point of contact that was transferred and it is hoped that the education to be gleaned from the elaborate displays of producers has favorably impressed buyers with domestic products and will make itself felt in a return to normal business. Both

aniline oil and *salts* are weaker than they were during the previous period. Although producers' prices for the former remain the same at 30c., odd lots are obtainable as low as 28c. per lb. The *salts*, which is extremely dull, took another tumble, the present figures being 33½@36c., compared with 35@40c. per lb. of last week. *Naphthalene* is also easier, being obtainable at 12@14c. per lb.

WAXES

Slight activity has been characteristic of this market for some time back, especially *beeswax*, which has been exceptionally dull, business being done as low as 30c. per lb. *Carnauba* is in almost the same position, spot offerings of No. 3, North Country, being at 29c. per lb. *Japan* is the possible exception to an otherwise weak market and with the present lively demand 19@21c. is a firmly sustained price. Small inquiry and a drop in cost of importing have combined to weaken *montan*, which can be obtained as low as 15c. per lb. for crude grade.

CRUDE RUBBER

This branch of the market has not shown the slightest indication of improvement since the slump which started early in January, 1920. The tendency has been steadily downward, until now the present prices are less than half of what they were nine months ago. In this period of time several large and well established firms have gone under, dragging with them all those who were connected with them in a business way. The point has been reached where brokers hesitate to take orders except for immediate delivery as the future is very indefinite and none too promising.

MISCELLANEOUS MATERIALS

Barytes continues scarce and although the car supply is considerably better than it has been for some time previous, \$22@\$25 per ton, f.o.b. Kings Creek, S. C., is still the ruling figure. *Shellac*, on the other hand, has taken a tumble and is quoted about 20c. per lb. below what were formerly prevailing prices, *orange fine* being now listed at \$1.15@\$1.30 and T.N. at 85@95c. per lb. No change has been noticed in the *feldspar* situation since the last increase of \$1 per ton. Current quotations, f.o.b. North Carolina and New York State, are firm at \$17@\$21 per ton.

The Chicago Market

Chicago, September 28, 1920.

The chemical market in practically all its phases remains quiet to an extreme degree, the only noticeable stiffening occurring in the vegetable oil trade. The closing of some producing plants of corn oil has caused the slack to be taken up on that item and the entire line has profited thereby. Sharp reduction in peanuts, in spite of the continuing steady price of the oil, does not look encouraging.

The great wave of price cutting which is apparently sweeping the country has for the present left the chemical industry unscathed. The reason is simple. The prolonged period of dullness in the trade has squeezed all the gas out of prices and no further material reductions can be made unless founded on lower production costs. Chemicals are basic in many industries. The steady shrinkage in prices for many weeks past should have warned wise ones in other lines that a break was coming. Local interests in the chemical line consider it fortunate that chemical prices have had their downward movement before this wave in other lines occurred, as they are now on a firm basis and are safe from stampede.

One effect of the quiet period has been to squeeze out of the trade a great many dealers in second hands—the manipulators and speculators who thrived on other people's troubles. More and more the market is seen to be in the hands of the manufacturers and their representatives, and their conservative price ideas will undoubtedly hold the market steady.

HEAVY CHEMICALS

Weak demand and corresponding lack of anxiety to make sales combine to make a stagnant market. Although quotations are freely made and inquiries fairly numerous,

actual transactions are few in most commodities. Prices are, in general, firmly held by first hands, middlemen having been largely eliminated. As yet, no contract prices have been announced on *alkalis*, and trading remains at a minimum in everything but *bleaching powder*, which is still hard to get and brings 7@8c. per lb., with the higher price prevailing. *Caustic soda* brings \$3.85@\$4 per cwt. for spot goods said to have been returned from the Orient, while fresh goods bring \$4.25@\$4.35. *Soda ash*, with weak demand, is quoted at \$2.65@\$2.75 for spot delivery in small lots. Supply of *sal soda* just about equals demand and price remains unchanged at \$2 per cwt., in less than car lots.

Supplies of *alcohol* of all grades are gradually more nearly approaching the demand, with no indications of price variations seen. *Ethyl*, quoted at \$5.65 per gal. for 190 proof, is absorbed as speedily as offered. *Methyl*, following a reduction in demand for export, is in better supply than formerly and goes for \$3.40 per gal. for 97 per cent. *Denatured* holds firm at \$1.12 per gal.

Benzoic acid has shown a reduction to 80c. for U. S. P. grade and 65c. for technical. *Benzoate of soda*, under weakened demand, has been reduced by intermediates to 75c. per lb. Supply is plentiful, but makers are holding their offering price firm at 80c.

Few transactions have been recorded in *glycerine*. Many prices are heard in this connection ranging from 26c. to 28c. for dynamite grade, with the few sales being closed probably around 27c. per lb. *Mercury* is likewise quiet at \$75 a flask quoted. Needle grade *antimony*, quoted by original sources at 13c. per lb., is obtainable from dealers' stocks at 1c. less. *Oxide*, firmly held by producers, cannot be found for less than 14c. *Red arsenic*, in a dull market, is quoted at 16c. per lb., but the *white* variety is more firmly held at 15c., immediate delivery. Inquiries are numerous but sales few, as buyers seem to expect concessions. No *brimstone* is found in the hands of speculative interests and price is firm at \$20 a ton.

Among the acids, *sulphuric* at \$22 a ton for 66 degree is being bought in sufficient quantities to fill actual needs, no contracts having been noted. *Carbolic*, with the Government price of 12c. per lb. still in effect, has been subject to but light demand, export trade being reported as lessening. Improved production conditions have induced a price of 75c. per lb. for *citric*. Traders have plentiful supplies which are offered as low as 10c. below quotation. It is reported sales are passing at an even lower figure. *Glacial acetic* is weak, quotations ranging from 12½c. to 15c. per lb. and but few sales recorded.

COAL-TAR PRODUCTS

Stagnant market features, so long prominent, have been relieved only by an increase in inquiries, actual purchases still being for minimum requirements. *Picric acid*, having no active market, is quoted at 30c. per lb. Overstocks have been piling up for some time in *salicylic acid*, U. S. P. grade, and price is down to 45c. per lb. Technical grade is comparatively stronger at 37c. per lb. *Benzene* and *toluene* are by no means plentiful and are steadily held at 38c. and 35c. per gal., respectively. Futures on benzene are 2c. below spot, all offerings being speedily absorbed by the trade. *Cresol*, steady at 18½@19c. per lb., and *phenol*, firm at 12c., are equally in demand. *Naphthalene* is very erratic, buyers and sellers alike playing a waiting game, with price ideas ranging from 13c. to 15c. per lb. Most of the few spot sales were at 14@15c.

Trade in *intermediates* continues on such an abbreviated scale that quotations are purely nominal and, as such, are of questionable value. The items which have been most scarce are becoming more easily obtainable, but actual movements of goods are a rarity.

VEGETABLE OILS

Some brightness has been noted in this line, as curtailed production in *corn oil*, occasioned by shutting down of some producers on account of current market being below cost, has created a present shortage. *Crude* is bringing 10½@11½c. in tanks f.o.b. plant, and *refined oil*, spot Chicago, is going readily at 15½c. in barrels.

Trade in *linseed* oil is at a minimum, the crushers of flax seed refusing to make further reductions and the trade being loath to pay current prices in the face of apparently an unlimited supply of both domestic and South American seed. Carloads are quoted for immediate delivery at \$1.10 @ \$1.12 per gal., with futures 5@6c. less. Jobbers' price to dealers in less than 5-bbl. lots is \$1.45. *Coconut oil*, with demand light, is firmly held at 13½@14c. per lb. for Manila grade in sellers' tanks, f.o.b. coast. The same grade f.o.b. Chicago is 16½c. in barrels. Demand for *cottonseed oil*, while still not good, is, however, better than recently. Price is steady at 13½@14½c. per lb. for prime summer yellow. Refined deodorized is priced at 15½@15¾c. in barrels f.o.b. Chicago.

Peanut oil, facing sharp reduction in the cost of imported peanuts, is held firm at 11½@11¾c. per lb. for crude in sellers' tanks on the coast. Edible grade is readily absorbed at 16½c. No transactions are registered in *red oil*, nominal quotation being unchanged at 13½c., spot delivery. Actual offers would probably induce shading. *Soya bean oil* is equally quiet, local price on crude being 13½c. per lb.

NAVAL STORES

The naval stores line is absolutely inactive. *Turpentine* is bad and *rosin* worse. Labor troubles in Europe have practically put a stop to export business and local buyers are simply not in the field. Price of *turpentine* is unchanged, \$1.47 ruling for drums in less than car lots. Small lots in barrels are quoted by jobbers at \$1.56 per gal. *Rosin*, with no variation shown between good and poor grade material, is offered in less than car lots at \$13.70@ \$13.80 per cwt. *Pine oil*, as usual in supply only partially equal to demand, holds firm at the high figure of \$1.90 per gal. for either pure steam or destructively distilled.

The St. Louis Market

St. Louis, Mo., September 28, 1920.

There has been little change in the chemical market here during the past two weeks and prices of most chemicals are stationary. The market may be characterized as quiet, with good supplies of practically all lines of chemicals on hand. Demand is fair. Manufacturers say that production is normal.

It is thought by producers that prices on chemicals will not show any tendency to decrease at present, because of the fact that the readjustment in the chemical industry took place during the first six months of 1919.

Numbers of contracts are being renewed by buyers of acids and in addition a good percentage of business on new contracts is being made. Producers believe they will be able to dispose of all their output for the coming year without any trouble. No fear of curtailment of output is felt.

Sulphuric acid continues in good demand, with prices firm. The quotation on the 60-deg. grade is \$16 per ton and that on the 66 deg. grade is \$24 per ton. *Oleum* continues firm at \$27.50 per ton.

There is a slightly better demand for *muriatic acid*, but prices are unchanged at \$25 per ton and 2@2½c. in carboys. The shortage reported two weeks ago has not eased materially.

The supply of *sodium bisulphate* remains ample, but prices are holding firmly. There was a slight reduction a month ago, but since that time quotations have shown no tendency to drop further. The price is \$5@5½ per ton.

The demand for *nitric acid* and for standard *mixed acid* is fairly strong and prices are unchanged. The quotations on *nitric acid* are \$7 per cwt. for the 36 deg. and \$10 per cwt. for 42 deg. The quotation on standard *mixed acid*, consisting of 36 per cent nitric and 61 per cent sulphuric, is the same, 11½c. per lb. of nitric and 1½c. per lb. of sulphuric acid.

There has been no change in the price of *zinc chloride*, which is in good demand. The price on the 50 per cent solution zinc chloride is \$4 per cwt.

Plentiful Government supplies of *phenol* are still being disposed of by a local firm at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.65 - \$0.75
Acetone.....lb.	\$0.15 - \$0.20	21 - 22
Acid, acetic, 28 per cent.....cwt.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent.....cwt.	6.50 - 7.50	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboys.....lb.	14.00 - 16.00	16.25 - 18.00
Boric, crystals.....lb.	15½ - 16	16½ - 19
Boric, powder.....lb.	15½ - 16½	17 - 20
Citric.....lb.	78 - 80	82 - 84
Hydrochloric (nominal).....cwt.	2.00 - 2.50	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal).....lb.	15 - 16	16½ - 18
Lactic, 44 per cent tech.....lb.	10 - 11	12 - 16
Lactic, 22 per cent tech.....lb.	04 - 05	06 - 07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	06 - 07	07½ - 08½
Nitric, 42 deg.....lb.	07½ - 08	08½ - 09½
Oxalic, crystals.....lb.	45 - 50	52 - 55
Phosphoric, Ortho, 50 per cent solution.....lb.	18 - 23	24 - 25
Pieric.....lb.	28 - 35	40 - 50
Pyrogallol, resublimed.....lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars.....ton	12.00 - 16.00	
Sulphuric, 60 deg., drums.....ton		18.00 - 20.00
Sulphuric, 66 deg., tank cars.....ton	16.00 - 17.00	
Sulphuric, 66 deg., drums.....ton	26.00 - 28.00	
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - 45.00
Tannic, U. S. P.....lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech.).....lb.	60 - 70	80 - 90
Tartaric, crystals.....lb.		74 - 77
Tungstic, per lb. of WO.....lb.		1.20 - 1.40
Alcohol, Ethyl (nominal).....gal.	5.50 - 5.75	6.00 - 7.00
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof (nominal).....gal.		1.12 - 1.15
Alcohol, denatured, 190 proof (nominal).....gal.		1.05 - 1.10
Alum, ammonia lump.....lb.	05 - 05½	05½ - 06
Alum, potash lump.....lb.	08½ - 08	09 - 09½
Alum, chrome lump.....lb.		18 - 19
Aluminum sulphate, commercial.....lb.	04½ - 06	
Aluminum sulphate, iron free.....lb.	09½ - 10½	11 - 12
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	35 - 35½	36 - 37
Ammonia, anhydrous, cylinders (100-150 lb.).....lb.	16 - 16½	17 - 18
Ammonium carbonate, powder.....lb.		
Ammonium chloride, granular (white sal-ammoniac) (nominal).....lb.	15½ - 16½	17 - 18
Ammonium chloride, granular (gray sal-ammoniac).....lb.	13 - 13½	13½ - 14½
Ammonium nitrate.....lb.	09 - 10	11 - 14
Ammonium sulphate.....lb.	07 - 07½	08½ - 09
Amylacetate.....gal.		5.00 - 5.25
Amylacetate tech.....gal.		4.75 - 5.25
Arsenic, oxide, lumps (white arsenic).....lb.	15 - 16	16½ - 17
Arsenic, sulphide, powdered (red arsenic).....lb.	16 - 18	19 - 23
Barium chloride.....ton	130.00 - 150.00	
Barium dioxide (peroxide).....lb.	21 - 23	24 - 25
Barium nitrate.....lb.	10 - 12	12½ - 13½
Barium sulphate (precip.) (blanc fixe).....lb.	04½ - 05	05½ - 06
Bleaching powder (see calcium hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.	70 - 90	1.00 - 1.05
Bromine.....cwt.	3.50 - 3.55	
Calcium acetate.....lb.	04½ - 04	04½ - 05½
Calcium carbide.....ton	33.00 - 34.00	35.00 - 45.00
Calcium chloride, fused, lump.....lb.	02 - 02½	03 - 03½
Calcium chloride, granulated.....cwt.	7.25 - 7.50	8.00 - 8.50
Calcium hypochlorite (bleaching powder).....lb.		1.50 - 1.70
Calcium peroxide.....lb.		75 - 80
Calcium phosphate, monobasic.....lb.		25 - 30
Calcium sulphate, pure.....lb.	08 - 09	10 - 11
Carbon bisulphide.....lb.	14 - 15	16 - 17
Carbon tetrachloride, drums.....lb.		1.25 - 1.50
Carbonyl chloride (phosgene).....lb.		
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.	09 - 09½	10 - 10½
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	40 - 43	44 - 47
Chloroform.....lb.		2.00 - 2.05
Cobalt oxide.....lb.		
Copperas (see iron sulphate).....lb.	27 - 28	29 - 31
Copper carbonate, green precipitate.....lb.		65 - 70
Copper cyanide.....lb.	08 - 09	09 - 09½
Copper sulphate, crystals.....lb.		
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.	1.10 - 1.30	1.40 - 1.75
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.		
Formaldehyde, 40 per cent (nominal).....lb.	48 - 50	5.25 - 6.00
Fusel oil, ref.....gal.		
Fusel oil, crude (nominal).....gal.		
Glauber's salt (see sodium sulphate).....lb.		26½ - 28½
Glycerine, C. P. drums extra.....lb.	4.30 - 4.35	4.40 - 4.45
Iodine, resublimed.....lb.		03 - 20
Iron oxide, red.....cwt.	2.00 - 2.25	2.35 - 2.75
Iron sulphate (copperas).....lb.		13½ - 16
Lead acetate, normal.....lb.	11 - 12	13 - 17
Lead arsenate (paste).....lb.		90 - 1.00
Lead nitrate, crystals.....lb.	14 - 15	15½ - 16
Litharge.....lb.		1.50 - 1.60
Lithium carbonate.....lb.	12½ - 13½	15 - 16
Magnesium carbonate, technical.....100 lb.	3.50 - 3.90	4.00 - 4.50
Magnesium sulphate, U. S. P.....100 lb.		3.50 - 3.60
Magnesium sulphate, commercial.....100 lb.		3.25 - 3.30
Methanol, 95%.....gal.		3.50 - 4.50
Methanol, pure.....gal.		3.50 - 4.50
Nickel salt, double.....lb.		14 - 16
Nickel salt, single.....lb.		13 - 14
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	50 - 55	60 - 65
Phosphorus, yellow.....lb.		35 - 37
Potassium bichromate.....lb.	34 - 36	39 - 40

	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb. \$0 52 - \$0 56	\$0 57 - \$0 58
Potassium bromide, granular	lb.	70 - 73
Potassium carbonate, U. S. P.	lb. 50 - 55	56 - 60
Potassium carbonate, crude	lb. 20 - 21	23 - 25
Potassium chlorate, crystals	lb. 18 - 18½	19 - 20
Potassium hydroxide (caustic potash)	lb. 27 - 28	29 - 33
Potassium iodide	lb.	3.35 - 3.60
Potassium nitrate	lb. 17 - 17½	19 - 21
Potassium permanganate	lb. 75 - 80	85 - 95
Potassium prussiate, red	lb. 85 - 95	1.00 - 1.05
Potassium prussiate, yellow	lb. 32 - 36	35 - 40
Potassium sulphate (powdered)	ton \$240.00 - 255.00	
Rochelle salts (see sodium potas. tartrate)		
Sal ammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake	ton 48.00 - 50.00	
Silver cyanide (nominal)	oz. 1.25 -	
Silver nitrate (nominal)	oz.	62
Soda ash, light	100 lb. 2.80 - 3.00	
Soda ash, dense	100 lb. 3.25 - 3.50	
Sodium acetate	lb. 10 - 15	20 - 25
Sodium bicarbonate	100 lb. 2.50 - 2.75	3.00 - 3.50
Sodium bichromate	lb. 22 - 24	26 - 27
Sodium bisulphate (nitre cake)	ton 7.00 - 8.00	9.00 - 11.00
Sodium bisulphate Powdered, U.S.P.	lb. .08½ - .10	10 - 11
Sodium borate (borax)	lb. .09 - .10	11 - 12
Sodium carbonate (sal soda)	100 lb. 2.00 - 2.10	2.15 - 2.25
Sodium chlorate	lb. 11 - 12	12½ - 14
Sodium cyanide, 96-98 per cent.	lb. 25 - 30	32 - 35
Sodium fluoride	lb. 18 -	19 - 20
Sodium hydroxide (caustic soda)	100 lb. 5.60 - 5.70	5.75 - 6.00
Sodium hypsulphite	lb. . . . .	.03 - .04
Sodium molybdate	lb. 2.50 -	3.25 -
Sodium nitrate	100 lb. 3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb. 16 - 18	19 - 20
Sodium peroxide, powdered	lb. 32 - 35	35 - 40
Sodium phosphate, dibasic	lb. .03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts) lb.		39 - 40
Sodium persulfate, yellow	lb. 25 - 27	31 - 32
Sodium silicate, solution (40 deg.)	lb. .01½ - .01½	.02 - .02½
Sodium silicate, solution (60 deg.)	lb. .02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt) cwt.	2.25 - 2.50	2.60 - 2.75
Sodium sulphide, crystals	lb. .09 - .10	.10 - .11
Sodium sulphite, crystals	lb. .04 - 0.4½	.04½ - .11
Strontium nitrate, powdered	lb. 15 - 18	19 - 20
Sulphur chloride red	lb. .08 - .09	10 - 10½
Sulphur, crude	ton 16.00 - 20.00	
Sulphur dioxide, liquid, cylinders	lb. .09 -	10 - 12
Sulphur (sublimed), flour	100 lb. 3.80 - 4.35	
Sulphur, roll (brimstone)	100 lb. 3.40 - 3.90	
Tin bi-chloride (stannous)	lb. 42½ - 44	45 - 46
Tin oxide	lb.	55 - 65
Zinc carbonate, precipitate	lb. 16 - 18	19 - 20
Zinc chloride, gran.	lb. 13 - 13½	13½ - 17
Zinc cyanide	lb. 45 - 49	50 - 60
Zinc dust	lb. 12 - 13	13 - 14
Zinc oxide, U. S. P.	lb. 17 - 25	
Zinc sulphate	lb. .03½ - .03½	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb. \$1.30 - \$1.40
Alpha naphthol, refined	lb. 1.50 - 1.65
Alpha-naphthylamine	lb. .48 - .52
Aniline oil, drums extra	lb. .30 - .33
Aniline salts	lb. .34 - .36
Anthracene, 80% in drums (100 lb.)	lb. .90 - 1.00
Benzaldehyde (f.f.c.)	lb. 2.00 - 2.10
Benzidine, base	lb. 1.35 - 1.40
Benzidine sulphate	lb. 1.15 - 1.25
Benzoic acid, U. S. P.	lb. .85 - .90
Benzoate of soda, U. S. P.	lb. .80 - .90
Benzene, pure, water-white, in drums (100 gal.)	gal. .35 - .40
Benzene, 90% in drums (100 gal.)	gal. .33 - .38
Benzyl chloride, 95-97% refined	lb. .35 - .40
Benzyl chloride, tech	lb. .25 - .35
Beta-naphthol benzoate (nominal)	lb. 3.50 - 4.00
Beta-naphthol, sublimed (nominal)	lb. .70 - .75
Beta-naphthol, tech (nominal)	lb. .65 - .70
Beta-naphthylamine, sublimed	lb. 2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)	lb. .18 - .19
Ortho-cresol, in drums (100 lb.)	lb. .23 - .25
Cresylic acid, 97-99%, straw color, in drums	gal. 1.10 - 1.15
Cresylic acid, 95-97%, dark, in drums	gal. 1.05 - 1.10
Cresylic acid, 50%, first quality, drums	gal. .65 - .75
Dichlorobenzene	lb. .07 - .10
Diethylaniline	lb. 1.50 - 1.60
Dimethylaniline	lb. .90 - 1.00
Dinitrobenzene	lb. .30 - .37
Dinitrochlorobenzene	lb. .32 - .35
Dinitronaphthalene	lb. .45 - .55
Dinitrophenol	lb. .40 - .45
Dinitrotoluene	lb. .40 - .40
Dip oil, 25% tar acids, car lots, in drums	gal. .38 - .40
Diphenylamine (nominal)	lb. .80 - .85
H-acid (nominal)	lb. 1.90 - 2.05
Meta-phenylenediamine	lb. 1.25 - 1.30
Monochlorobenzene	lb. .18 - .20
Monoethylaniline	lb. 2.00 - 2.40
Naphthalene crushed, in bbls. (250 lb.)	lb. .12 - .14
Naphthalene, flake	lb. .16 - .17
Naphthalene, balls	lb. .16 - .17
Naphthionic acid, crude	lb. .75 - .85
Nitrobenzene	lb. .14 - .19
Nitro-naphthalene	lb. .40 - .50
Nitro-toluene	lb. .18 - .25
Ortho-amidophenol	lb. 3.25 - 4.25
Ortho-dichlorobenzene	lb. .15 - .20
Ortho-nitro-phenol	lb. .80 - .85
Ortho-nitro-toluene	lb. .25 - .40
Ortho-toluidine	lb. .35 - .38
Para-amidophenol, base	lb. 2.50 - 3.00
Para-amidophenol, HCl	lb. 2.50 - 3.00
Para-dichlorobenzene	lb. .08 - .12
Paranitroaniline	lb. 1.10 - 1.15

Para-nitrotoluene	lb. 1.25 - 1.40
Para-phenylenediamine	lb. 2.30 - 2.65
Para-toluidine	lb. 2.00 - 2.25
Phthalic anhydride	lb. .60 - .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb. .12 - .20
Pyridine	gal. 2.00 - 3.50
Resorcinol, technical	lb. 4.25 - 4.50
Resorcinol, pure	lb. 6.25 - 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb. .45 - .50
Salicylic acid, U. S. P.	lb. .45 - .50
Salol	lb. .90 - 1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal. .30 - .35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal. .30 - .26
Sulphanilic acid, crude	lb. .32 - .35
Toluidine	lb. 1.70 - 2.50
Toluidine, mixed	lb. .45 - .55
Toluene, in tank cars	gal. .35 - .40
Toluene, in drums	gal. .38 - .40
Xylidines, drums, 100 gal.	lb. .50 - .65
Xylene, pure, in drums	gal. .47 - .50
Xylene, pure, in tank cars	gal. .45 - .50
Xylene, commercial, in drums, 100 gal.	gal. .32 - .35
Xylene, commercial, in tank cars	gal. .30 - .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb. \$0.33 - \$0.38
Beeswax, refined, light	lb. .34 - .37
Beeswax, white pure	lb. .60 - .65
Carnauba, No. 1 (nominal)	lb. .90 - .95
Carnauba, No. 2, regular (nominal)	lb. .85 - .86
Carnauba, No. 3, North Country	lb. .35 - .36
Japan	lb. .18 - .20
Montan, crude	lb. .14 - .15
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb. .09 - .09½
Paraffine waxes, crude, scale 124-126 m.p.	lb. .09½ - .10
Paraffine waxes, refined, 118-120 m.p.	lb. .11 - .11½
Paraffine waxes, refined, 125 m.p.	lb. .12½ - .13
Paraffine waxes, refined, 128-130 m.p.	lb. .13 - .15
Paraffine waxes, refined, 133-135 m.p.	lb. .16 - .17
Paraffine waxes, refined, 135-137 m.p.	lb. .17½ - .18½
Stearic acid, single pressed	lb. .20 - .21
Stearic acid, double pressed	lb. .22 - .23
Stearic acid, triple pressed	lb. .24 - .25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940	gal. \$2.15
Pine oil, pure, dest. dist.	gal. 1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal. .48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal. .35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal. .85
Pine tar, ref., thin, sp. gr. 1.080-1.960	gal. .36
Turpentine, crude, sp. gr. 0.900-0.970	gal. 1.75
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990	gal. .35
Pinewood creosote, ref.	gal. .52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb. \$13.00 -
Rosin E-I	280 lb. 13.10 -
Rosin K-N	280 lb. 13.15 -
Rosin W-G-W-W	280 lb. 13.25 -
Wood rosin, bbl.	280 lb. 12.50 -
Spirits of turpentine	gal. 1.39 -
Wood turpentine, steam dist.	gal. . . . -
Wood turpentine, dest. dist.	gal. . . . -
Pine tar pitch, bbl.	200 lb. . . . - 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl. 14.50 - 15.00
Retort tar, bbl.	500 lb. 15.00 - 15.50
Rosin oil, first run	gal. .72 -
Rosin oil, second run	gal. .75 -
Rosin oil, third run	gal. .92 -

Solvents

73-76 deg., steel bbls. (85 lb.)	gal. \$0.40
70-72 deg., steel bbls. (85 lb.)	gal. .38
68-70 deg., steel bbls. (85 lb.)	gal. .37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal. .29

Crude Rubber

Para-Upriver fine	lb. \$0.26 - \$0.26½
Upriver coarse	lb. .17 - .18
Upriver caucho ball	lb. .17½ - .18½
Plantation—First latex crepe	lb. .25 -
Ribbed smoked sheets	lb. .24 -
Brown crepe, thin, clean	lb. .22 -
Amber crepe No. 1	lb. .22 -

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb. \$0.16½ - \$0.18
Castor oil, AA, in bbls.	lb. .17 - .17½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb. .17½ - .18
Cocoonut oil, Ceylon grade, in bbls.	lb. .15 - .16
Cocoonut oil, Cochui grade, in bbls (nominal)	lb. .16 - .17½
Corn oil, crude, in bbls.	lb. .12 - .13
Cottonseed oil, crude (f.o.b. mill)	lb. 10½ - .11
Cottonseed oil, summer yellow	lb. .14 - .15
Cottonseed oil, winter yellow	lb. . . . -
Lined oil, raw, car lots (domestic)	gal. 1.22 -
Linseed oil, raw, tank cars (domestic)	gal. 1.16 -
Linseed oil, boiled, car lots (domestic)	gal. 1.24 -

Olive oil, commercial.....	gal.	3.00	—	3.50
Palm, Lagos.....	lb.	10½	—	—
Palm, bright red.....	lb.	—	—	—
Palm, Niger.....	lb.	—	—	10
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	10½	—	12½
Peanut oil, refined, in bbls.....	lb.	17	—	18
Rapeseed oil, refined in bbls.....	gal.	1.30	—	1.45
Rapeseed oil, blown, in bbls.....	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	14	—	14½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	10	—	11

FISH

Winter pressed Menhaden.....	gal.	\$0.85	—	\$0.90
Yellow bleached Menhaden.....	gal.	.87	—	.90
White bleached Menhaden.....	gal.	.90	—	.92
Blown Menhaden.....	gal.	1.05	—	—

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$22.00	—	\$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	—	20.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	8.00	—	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	—	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	—	19.00
Barytes, crude, 88% @ 94% ba., Cartersville	net ton	12.00	—	—
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	—	11.25
Blanc fixe, dry.....	lb.	.05½	—	.06
Blanc fixe, pulp.....	net ton	60.00	—	\$0.00
Casein.....	lb.	.15	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04½	—	.05½
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.05
Chalk, English, dense.....	lb.	.04½	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	—	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	7.50	—	8.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	30.00	—	35.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	—
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	—	—	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	—	—	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	—	—	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	—	—	.10
Graphite, crucible, 85% carbon.....	lb.	—	—	.08
Graphite, crucible, 88% carbon.....	lb.	—	—	.09½
Graphite, crucible, 90% carbon.....	lb.	—	—	.10½
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic, lump.....	lb.	.06	—	—
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	—	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.15	—	1.30
Shellac, orange superfine.....	lb.	1.10	—	1.20
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Soapstone.....	ton	15.00	—	25.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Talc, California Talcum Powder grade.....	ton	20.00	—	35.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh.....	1,000	—	160	—
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	—	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55-60	—	—
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	—	—
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	—	55-60	—
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	—	45-50	—
Magnesite brick, 9-in. straight.....	net ton	110	—	—
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	—	—
Magnesite brick, soaps and splits.....	net ton	134	—	—
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	—	65-70	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	—	56-61	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	—	55-60	—

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.18	—	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.20	—	.21
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	175.00	—	180.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	170.00	—	175.00
Spiegel, 18-22% Mn.....	lb.	80.00	—	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	gross ton	2.50	—	3.00
Ferro-silicon, 10-15%.....	gross ton	60.00	—	65.00
Ferro-silicon, 50%.....	gross ton	80.00	—	90.00
Ferro-silicon, 75%.....	gross ton	150.00	—	160.00
Ferro-tungsten, 70-80% per lb. of contained W.....	lb.	.90	—	1.05
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6.50	—	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than 14% moisture	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.70	—	.75
Chrome ore, 50% max., Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.75	—	.80
*Coke, foundry, f.o.b. ovens.....	net ton	17.00	—	18.00
*Coke, furnace, f.o.b. ovens.....	net ton	16.00	—	16.50
*Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	24.00	—	—
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	—	—
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	25.00	—	27.50
Ilmenite, 52% TiO ₂ , per b. ore.....	lb.	.014	—	.014
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.60	—	.70
Manganese ore, chemical (MnO ₂).....	gross ton	75.00	—	90.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.70	—	.75
Monazite, per unit of ThO ₂	unit	42.00	—	—
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	—
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	—
Pyrites, Spanish, run of mines, c.i.f. Atlantic seaport.....	unit	.12	—	.14
Pyrites, domestic, fines.....	unit	.12	—	.14
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.15	—	—
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃	unit	6.00	—	—
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	5.00	—	—
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	1.25	—	—
Zircon, washed, iron free.....	lb.	.10	—	—

*Nominal

Non-Ferrous Metals

New York Markets

Copper, electrolytic.....	Cents per lb.	18.50
Aluminum, 98 to 99 per cent.....		34.80
Antimony, wholesale lots, Chinese and Japanese.....		7.12 @ 7.25
Nickel, ordinary (Ingots).....		43.00
Nickel, electrolytic.....		45.00
Tin, 5-ton lots.....		44.50
Lead, New York, spot.....		8.50
Lead, E. St. Louis, spot.....		8.00
Zinc, spot, New York.....		8.50
Zinc, spot, E. St. Louis.....		7.70 @ 8.05

OTHER METALS

Silver (Commercial).....	oz.	\$0.914
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.55
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Niagara Falls).....	lb.	1.75
Platinum.....	oz.	115.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	100.00 @ 110.00
Mercury.....	75 lb.	75.00

FINISHED METAL PRODUCTS

Warehouse Price Cents per lb.

Copper sheets, hot rolled.....		33.50
Copper bottoms.....		38.00
Copper rods.....		38.00 @ 40.00
High brass wire and sheets.....		30.25
High brass rods.....		27.00
Low brass wire and sheets.....		28.50
Low brass rods.....		29.00
Brazed brass tubing.....		38.25
Brazed bronze tubing.....		41.75
Seamless copper tubing.....		34.00
Seamless high brass tubing.....		33.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	—New York—			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	15.00	17.00	14.00	15.00
Copper, heavy and wire.....	14.00	16.00	13.50	14.50
Copper, light and bottoms.....	12.50	14.00	12.00	13.00
Lead, heavy.....	7.00	4.75	7.00	7.00
Lead, tea.....	5.00	3.75	4.00	6.00
Brass, heavy.....	9.50	10.50	10.00	14.50
Brass, light.....	7.00	7.50	7.00	8.00
No. 1 yellow brass turnings.....	8.50	10.00	7.50	8.00
Zinc.....	5.00	5.00	4.50	5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	—New York—		—Cleveland—		—Chicago—	
	Current	One Month Ago	Current	One Month Ago	Current	One Month Ago
Structural shapes.....	\$4.58	\$4.47	\$3.47	\$5.00	\$3.37	\$4.08
Soft steel bars.....	4.73	4.62	3.37	4.50	3.27	3.98
Soft steel bar shapes.....	4.73	4.62	3.37	—	3.27	3.98
Soft steel bands.....	6.43	6.32	4.07	6.25	—	—
Plat. s. ½ to 1 in. thick.....	4.78	4.67	3.67	4.50	3.57	4.28

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

FORT SMITH—The Harding Glass Co., Kelley Highway and North 11th St., plans to build a glass plant. Estimated cost, \$175,000.

Colorado

JOHNSTOWN—The Great Western Sugar Co., Sugar Bldg., Denver, is building a sugar factory. Estimated cost, \$2,000,000. E. F. Morrison, Sugar Bldg., Denver, engr.

Illinois

EARLVILLE—The city is having plans prepared for the construction of a sewer system and sewage disposal plant. Estimated cost, \$100,000. W. S. Shields, 8 South Dearborn St., Chicago, engr.

EAST ST. LOUIS—The T. J. Moss Tie Co., Security Bldg., plans to build a wood creosoting plant on Cahokia Rd. and the Terminal R.R. tracks. Estimated cost, \$25,000. J. W. Fristoe, pres.

Kansas

TOPEKA—T. W. Williamson & Co., 418 Central Natl. Bank Bldg., will receive bids in October for the construction of a hospital and detention building for the Security Benefit Association. A chemical laboratory will be installed in same. Estimated cost, \$300,000. Schmidt, Garden & Martin, 104 South Michigan Ave., archts.

Louisiana

BOGALUSA—The Great Southern Lumber Co. has awarded the contract for the construction of a paper mill addition to Stone & Webster, 120 Bway., New York City. Estimated cost, \$250,000.

Maryland

BALTIMORE—The Amer. Can Co., Maryland Trust Bldg., will soon award the contract for the construction of a 4-story can factory on Hudson and Boston Sts. Estimated cost, \$500,000. C. Z. Treis, 120 Bway., New York City, engr. Noted Sept. 1.

BALTIMORE—The Kennedy Corp., Fidelity Bldg., has awarded the contract for the construction of a 1- and 2-story iron foundry addition on Charles and Wells Sts. to Frairie Bros. & Haigley, 13 Clay St. Estimated cost, \$100,000. J. P. Kennedy, pres.

CURTIS BAY (Baltimore P. O.)—The Compressed Carbonic Co. plans to build a chemical plant here near the plant of the United States Industrial Alcohol Co.

CURTIS BAY (Baltimore P. O.)—The Raison Monumental Co. is having plans prepared for the construction of 4 buildings which will replace the present buildings. The Raison Monumental Co. is a subsidiary of the Virginia-Carolina Chemical Co., Richmond, Va.

SALISBURY—The Peninsula General Hospital, Locust and South Division Sts., plans to build a hospital. A laboratory will be installed in same. Estimated cost, \$150,000. F. P. Adkins, chn. of the Bldg. Comm. C. L. Reeder, Park Ave. and Saratoga St., Baltimore, engr. Owens & Slaco, 1605 Continental Bldg., Baltimore, archts.

Massachusetts

SOMERSET—The Somerset Stove Fdry. Co. will soon award the contract for the construction of a 1-story foundry. Estimated cost, \$50,000. N. S. Chase, Borden Block, Fall River, engr.

Michigan

OWOSSO—The Amer. Malleable Co. has awarded the contract for the construction of a 1-story factory to the H. K. Ferguson Co., Vicks Bldg., Cleveland, O. Estimated cost, \$150,000.

Minnesota

BEMIDJI—The Stellar Co. plans to build a 1- and 2-story addition to factory for the manufacture of turpentine. D. C. Brown, secy.

ST. PAUL—H. W. Austin, purch. agt., City Hall, will soon award the contract for 30,000 lb. of liquid chlorine in 100-lb. cylinders for treating city water.

Missouri

ST. LOUIS—The Superior Enamel Products Co. has awarded the contract for the construction of a building and plant on the southwest corner of 10th and Mullanchy Sts.

New Hampshire

NASHUA—The Asbestos Wood Co., 40 Bridge St., has awarded the contract for the construction of a 1-story, 90x220-ft. plant addition on Belknap St. to D. F. Holt & Son, 282 Main St. Estimated cost, \$50,000.

New Jersey

BAYONNE—J. M. Huber, 65 West Houston St., New York City, will alter a 5-story factory. Estimated cost, \$35,000. Work will be done by day labor.

New York

ROCHESTER—The Rochester Castings Corp. is having plans prepared for the construction of a 1-story, 280x1,000-ft. brass foundry. J. F. Ancona, 307 Cutler Bldg., archt.

SHEEPSHEAD BAY (Brooklyn P. O.)—C. A. Benoit, Jerome Ave., has awarded the contract for the construction of a chemical factory to the Dose Eng. Co., 43 West 27th St., New York City. Estimated cost, \$150,000.

Ohio

SYDNEY—The Wagner Mfg. Co. is having plans prepared for the construction of a 1-story, 80x180-ft. foundry. Estimated cost, \$75,000. E. McGeorge, 1900 Euclid Ave., archt. and engr.

Oklahoma

BRUNER (Tulsa P. O.)—C. Page, pres. of the Sand Springs Home, plans to build a cement plant and large crusher, 1½ miles north of here on the Sand Springs Ry. in the Osage Hills. Estimated cost, \$100,000.

Pennsylvania

BUTLER—The Standard Steel Car Co. plans to construct a 2-story, 45x85-ft. building to include chemical, physical, foundry, microscopic, heat treatment and industrial laboratory divisions. Plans include a machine shop, etc. A. Christensen, chief research chemist. Richard Rimback, chief metallurgist.

JOHNSTOWN—The Cambria Steel Co. is having plans prepared for the construction of a 3-story, 60x170-ft. sintering plant. Estimated cost, \$300,000. A. S. McKee Co., 2422 Euclid Ave., Cleveland, O., engr.

HARRISBURG—The city has retained James H. Fuertes, consult. engr., 140 Nassau St., New York City, to prepare plans for the construction of a new intake filter plant, \$85,000. Six filters, \$100,500, settling basin, \$140,300, washing plant and new settling basin inlets, \$95,000 will be included in plans.

South Dakota

WAVERLY—The Bd. Educ. will soon receive bids for the construction of a 2-story, 80x109-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. M. T. Anthony, clk. Kirby T. Snyder, 739 Plymouth Bldg., Minneapolis, Minn., archt.

Texas

AUSTIN—The University of Texas Bd. of Regents is having plans prepared for the construction of a 3-story, 70x200-ft. school of chemistry. A chemical laboratory will be installed in same. Estimated cost, \$350,000. G. A. Endress, Littlefield Bldg., archt.

EL PASO—The Home Mission Bd., Southern Baptist Conference, has awarded the contract for the construction of several buildings, including 2 ward buildings, etc., to the C. W. Hedrick Constr. Co., Southwestern Life Bldg., Dallas. A septic tank and a sewage disposal tank will be installed in same. Estimated cost, \$300,000.

Wisconsin

WAUWATOSA—The Milwaukee Co. Bd. of Administration will soon award the contract for rebuilding the sewage disposal plant at the County Institutional Bldg. A sludge bed and filters will be installed in same.

MERRILL—The Bd. Educ. will soon receive bids for the construction of a 2-story, 60x200-ft. addition to the high school. A chemical laboratory will be installed in same. Estimated cost, \$200,000. Parkinson & Dockendorff, La Crosse, archts.

MILWAUKEE—The Red Star Yeast & Product Co., 27th and St. Paul Sts., is having plans prepared for the construction of a 2-story, 27x100-ft. yeast manufacturing plant on 27th St. Estimated cost, \$25,000. E. R. Liebert, 432 Bway., archt. and engr.

Manufacturers' Catalogs

THE SEMET-SOLVAT Co., Syracuse, N. Y., is issuing a folder on "Crysolite Protective Paint."

THE ARTHUR H. THOMAS Co., Philadelphia, has issued two new bulletins, one of which describes apparatus for the measurement of differences of potential by the potentiometer method with particular reference to the rapid and precise determination of H-ion concentration in solution. The other is entitled "A Series of Five Analytical Balances."

THE WILLMAN-SEEVER-MORGAN Co., Cleveland, O., has issued two new catalogs. Bull. No. 49 deals with W-S-M car dumpers and Bull. No. 41 deals with W-S-M coal- and ore-handling machinery.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION is holding its 1920 convention and exhibit at Columbus, Ohio, this week.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21.

INSTITUTE OF METALS DIVISION OF THE A. I. M. E. is holding its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, this week.

NATIONAL ASSOCIATION OF PURCHASING AGENTS will hold its annual convention at the Congress Hotel, Chicago, Ill., Oct. 11, 12 and 13.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.